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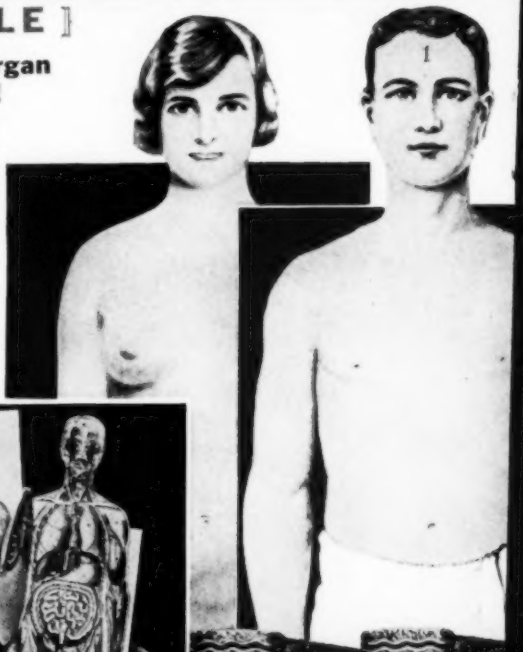

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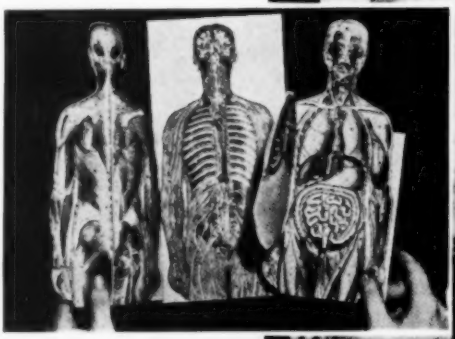

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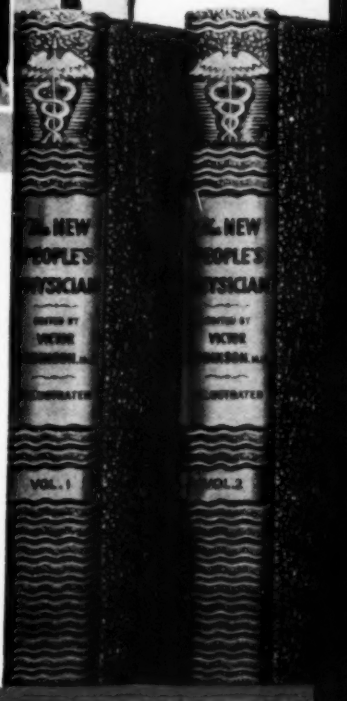


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**Mechanics & Handicraft**

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY


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JOSEPH ARONSON, who designed the Built-In Bookcases and Bar on page 164, has been studying and making furniture for more than 20 years. His New York studio is a busy workshop in which are employed some of America's most skillful craftsmen. Aronson can't design furniture on paper alone; he has to watch the developing wood, changing the design as it shapes up in three dimensions.


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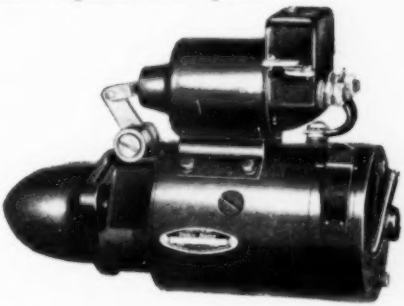

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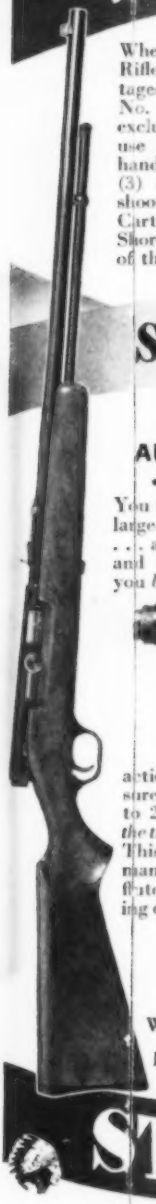
[ ] 16-19 yrs. [ ] 20-30 yrs. [ ] 31 yrs. and up [ ] under 16 yrs.

# YOU CAN USE *this* AUTOMATIC .22 Rifle *three ways*



When you select an automatic .22 Rifle, why not get the *extra* advantages offered you *only* in this Stevens No. 87 Springfield Brand .22? The exclusive cross-bolt enables anyone to use this rifle as (1) automatic, (2) hand-operated bolt-action repeater, (3) single loader. As automatic, it shoots *all* .22 Long Rifle and .22 Long Cartridges . . . . also high speed .22 Shorts. Operated by hand, it shoots all of the above, plus Regular .22 Shorts.

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**AUTOMATIC .22 RIFLE $16.45**

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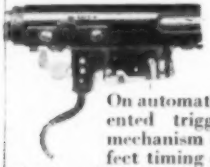

On automatic, this patented trigger release mechanism effects perfect timing of the bolt action in relation to feeding. It assures uninterrupted shooting of 15 to 21 shots *as fast as you can pull the trigger.*

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## Coming Next Month—

SALT is something you use every day. Without it, you couldn't enjoy a single meal. Do you know where it comes from, or what happens to it before it reaches your table? Or that the average person eats more than six pounds of salt each year? There are some surprising facts in an article on salt mining—and you won't have to take them with a grain of salt!

WORLD'S STINGIEST DRIVERS are the fuel-nursers who take part in the Gilmore Economy Run. Their purpose is to squeeze the last possible inch of running distance out of every drop of gasoline in their tanks. Read about this unique automobile event which shows the engineers how to give you more gasoline mileage on your own car. Plenty of pictures, too, to show you how it's done.

TYPEWRITERS take a lot of punishment. Few commonly used machines are more complicated and delicate, yet few receive more abuse. If you own a typewriter, or use one, you'll find some valuable tips in "First Aid for Typewriters." Written by the plant superintendent of the world's largest typewriter rebuilding concern, it tells you how to get the most out of your machine and how to make it last longer.

COLD-STORAGE SPACE for rent! That's the story of a booming new industry that promises to save Americans millions of dollars every year by providing lockers for food storage. There's plenty of food for thought in an article about these mammoth community ice boxes and their growing popularity.

MOST POPULAR HOBBY: Is it stamp collecting? Model railroading? Photography? The answer was disclosed by a survey designed to find out what people do for fun. See how your own hobby rates in the number of its devotees, the amount of money they spend on it, and what they get out of it.

"THE IDEAL MEDICINE CABINET" is what we asked for in a contest announced in our November issue. That our readers had plenty of ideas on the subject was shown by the response. In announcing the awards, we describe the prize-winning cabinets and summarize the general results. How does your own bathroom cabinet measure up to what we picked as the ideal?

YOU'RE like a million other men today—you're facing a big question. The last ten years turned business topsy-turvy and now the rebuilding period stares you in the face. The Defense program, new world conditions and the business pick-up offer new opportunities, but also new problems.

Where you are "going from here" is a question you want answered right if you expect to get ahead—progress—grow instead of standing still.

Are the things that are happening today going to help or hinder you—what will they mean in your pay check? Where will they put you five—ten—twenty years from now?

How can you take full advantage of this period of opportunity? We believe you will find the answer here—a suggestion the soundness of which can be proven to you as it has been to thousands of other men.

The whole trend today—legislation—spirit—action—is upward, up to higher business records than ever before. New factories, enlarged plants, new products are calling for more men.

Business organizations are rebuilding—organizing and expanding for the new conditions. Employees are being studied, judged as to how they fit in the expanding program, especially into the key and supervisory jobs which demand most and pay best. This spells real opportunity for the man who can meet the test—but heaven help the man who still tries to meet today's problems from yesterday's standpoint! Out of the multitude still jobless there are sure to be many frantically eager to prove him wrong and take his place.

### Some Men Have Found the Answer

Seeing these signs, many aggressive men and women are quietly training at home—are wisely building themselves for more efficient service to their employers. They are studying with us because our training courses are as fresh, vital and up-to-the-minute as the problems that face you today.

You naturally ask, "Has your training helped men withstand conditions of the last few years?"

Our answer is to point to a file of letters from thousands of our students reporting pay raises and promotions while business was at its lowest ebb—together with a myriad of others telling of greater success during these recent months of recovery.

Convincing evidence is ready for your investigation. We have assembled much of it in a booklet that is yours for the asking, along with a new and vitally interesting pamphlet on your business field.

This is a serious study of the possibilities and opportunities in that field. It is certain to contain an answer to vital questions bothering you today about your own work and earning power.

Send for these booklets—coupon brings them free. Be sure to check the LaSalle training that interests you most. We will tell you also how you can meet and take fullest advantage of today's situation. No cost or obligation—so why not mail the coupon now?

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CRANBERRIES ARE MORE THAN SAUCE! The lowly bog berry is destined to become the source of supply for two vital products, vitamin A and ursolic acid. The vitamin is obtained from cranberry-seed oil, ordinarily a waste product. The acid is a rare emulsifying agent which helps make oil and water mix, and is derived from the skins, another waste product. Plans for manufacturing the two new products are under way.

From the News Editor's Desk

A PREFABRICATED, ARC-WELDED STEEL "BUILDING BLOCK," which is framework and wall member in one unit, was used in construction of a unique seven-room home for Mr. and Mrs. R. G. Le Tourneau, near Toccoa, Ga. The house was completed in less than two months, half the time required by conventional methods. The new panels completely eliminate stud and joist framework in home construction; in larger buildings they do away with columns and roof beams. They are field-welded together by continuous welds to suit any design or arrangement. The Lincoln Electric Company, of Cleveland, Ohio, manufactured the shielded arc-welding equipment used. Meanwhile large plywood manufacturers of Chicago will soon place on the market another new building panel, faced on both sides with phenolic-impregnated cotton fabric.

THE FIRST AMERICAN CIGARETTE-PAPER MILL using home-grown products is ready to meet the industry's entire requirements, despite our complete prewar dependence on French sources. The mill uses California and Minnesota flax fiber, and is currently supplying one third of this country's enormous requirements for more than 180 billion cigarettes annually. French supplies on hand are sufficient for only six months.

VIRUSES OF DISEASE, invisible under optical microscopes, have now been photographed, according to Dr. Stuart Mudd of the University of Pennsylvania Medical School. The feat was performed with an electron microscope, which focuses a beam of electrons with electrified plates and coils. A baseball bat, enlarged in proportion with its magnification of 100,000 diameters, would measure about 50 miles long and four miles thick.

THE CHRONOSCOPE, developed by the Remington Arms Company, splits the second into a thousand parts, and measures from one to 200 of these milliseconds with less than one-percent error. It has already demonstrated its superiority over the Boulenge chronograph, the standard device in all ballistic studies. Its swinging needle also indicates how long it takes a fuse to blow out, a photoflash bulb to light, or a blasting cap to explode. The time interval is determined by measuring the quantity of electricity which passes through a specially designed galvanometer while the measured event is taking place.

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The map shows the locations of Frye Schools and Offices. In each spot—right next door—is one of the huge new aircraft plants of the national defense program. These Frye Schools are equipped and ready to prepare you to start right with the right kind of training.

### Good Jobs for Trained Men

Men trained by the Frye System will be in demand in the new plants, because they will be recognized as "properly trained." This System was developed by Donald Frye, who has been an executive in some of the largest aircraft plants in the U. S. He knows what the factories need. And you need what he knows and teaches.

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Factory personnel directors know that "Frye trained" means properly trained—they hired more than 1500 Frye graduates last year. Instructors are thoroughly competent. You learn under factory conditions. Classes are purposely limited in size so that each student is given individual attention. Frye schools are virtually next door to the new aircraft factories. Mail the coupon now for details.

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Rush complete information and details of low cost training course in the aircraft production.

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PS

# Readers Say:

## Old Man Winter Designs a New Hub-Cap Pattern

It's not easy for motorists to see any beauty in ice, which usually produces nothing for them more lovely than dented fenders and busted radiators. So I am sending you a photograph of an effect that was quite common around here during a recent spring thaw-and-freeze. On cars which had been plowing through deep slush, sunburst patterns appeared on hub caps where water, thrown off by centrifugal force, froze into radial icicles. As you see, the result is quite attractive — almost enough to reconcile a driver to plowing through the stuff.—J. A. M., Wayne, Neb.

## What Cat Wouldn't Volunteer To Serve as a Guinea Pig?

Not long ago, I saw some slow-motion pictures of a cat drinking milk, made with the Edgerton camera which makes 2,000 exposures a second. These showed the milk entering the cat's mouth under the tongue instead of on top of it. I couldn't believe this, so I made some tests with our own cat. First I gave him a saucer of milk and we watched the tongue operation. The milk appeared to be on top of the tongue. Then we placed some corn flakes in the milk, and I am sure that *they* went in on top of the tongue. I am wondering whether the slow-motion movie effect isn't another camera illusion.—O. C. T., West Lafayette, Ind.

## It's a Good Idea, But Somebody Patented It

According to an article published in your August, 1940, issue, an ingenious filling-station manager uses the lids of candy-bar boxes to make display racks by a simple method of cutting and folding them. The idea is a good one, but you should advise your readers not to follow his example. A carton cut as described is a direct infringement of claims 2, 4, and 5 of U. S. Patent No. 2,006,445 issued to Bruce J. Davidson and owned by the National Biscuit Company, New York. Several carton manufacturers have been licensed under the patent, and no one not so licensed can use the method without becoming an infringer of the patent.—V. B. C., New York City.

## Lots of Passengers Don't Feel Good on ANY Ship

Your article "America Rebuilds Her Merchant Marine" states that two new 35,500-ton passenger liners will be built with their funnels on one side so that they can be used as aircraft carriers. After spending millions on ships, why spoil their artistic lines in this way? I am sure the passengers wouldn't feel good traveling on such a funny-looking ship.—J. H. S., Detroit, Mich.

## Adding Up Numbers Was Child's Play to Him

Can some reader tell me whether the following has any practical meaning? I discovered as a child while playing with an adding machine that adding 1 to 2 to 3 to 4 and so on up to 10 equals 55; up to 100 equals 5050. Wouldn't up to 1,000 equal 500,500?—J. R. G., New York City.

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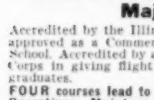


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Before I completed your lessons, I obtained my Radio Broadcast Operator's license and immediately joined Station WMPC where I am now Chief Operator.—HOLLIS F. HAYES, 527 Madison St., Lapeer, Michigan.

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**$15 a Week Extra in Spare Time**

I am doing spare time Radio work, and I am averaging from $700 to $850 a year. Those extra dollars mean so much—the difference between just barely getting by and living comfortably.—JOHN WASHKO, 97 New Cranberry, Hazelton, Penna.

Radio broadcasting stations employ Radio Technicians as operators, maintenance men, etc. Radio manufacturers employ testers, inspectors, servicemen in good-pay jobs. Radio jobbers and dealers employ installation and servicemen. Many Radio Technicians open their own Radio sales and repair businesses and make $30, $40, $50 a week. Others hold their regular jobs and make $5 to $10 a week fixing Radios in spare time. Automobile, police, aviation, commercial Radio loudspeaker systems, electronic devices are other fields offering opportunities for which N. R. I. gives the required knowledge of Radio. Television promises to open good jobs soon.

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CITY.....STATE.....

# Readers Say:

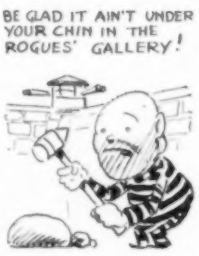
## Plane Markings on Our Cover Were the Real Thing

WHEN I received my February issue with the cover picture of Navy fighter planes, I was curious about the markings of the planes. One has a red strip around the cowling and around the fuselage near the back, but the other has the red strip only on the bottom of the cowling and none on the fuselage. Is it supposed to be that way, or is it a mistake?—R. W., Pine Grove, Pa.

*Artist McCoy made no mistake. Plane No. 1, with red strips around cowling and fuselage, is the "skipper" of the entire squadron. Each of the six sections in the squadron has a different color, and the leader of each section has strips of that color all around cowling and fuselage.—Ed.*

## Shh! It's a Secret Code That Shows We've Got Your Number

WHENEVER I receive my copy of P. S. M., I am puzzled by the series of letters and numbers that appears above my name on the address. I know this abracadabra means something to your circulation department, and I think that an article telling how the system works would be interesting to your readers.—L. P. C., Woonsocket, R. I.




## The Figures Were Wrong, But It's Still a Good Trick

J. E. H., who tells about his stroboscope trick with an auto-engine fan and alternating-current lamp, says: "Few people know that 60-cycle alternating current is on and off 60 times a second." That is incorrect. A 60-cycle alternating-current light goes on and off twice that often, or 120 times a second. What happens 60 times a second is the completion of the cycle.—D. K., Oakland, Calif.

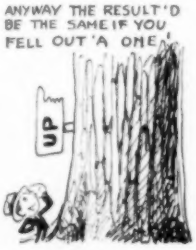
## What Can You Do with Some Empty Cheese Boxes?

DURING the last few months, many wooden cheese boxes have accumulated in my home. I wonder whether any other reader has an idea for using these boxes. There ought to be some use for them.—R.E.B., Canfield, Ohio.

*Let's have some suggestions for cheese-box projects!—Ed.*

## Tall Tales of Tall Trees Cut Down by Cold Facts

ON ONE of your recent "Un-Natural History" pages, you show a California redwood tree with the legend "200 to 400 feet high." As far as we know, through a search made by the Save-the-Redwoods League, the tallest redwood tree is 364 feet tall, and this is the tallest known standing tree. There have been stories of Australian trees of the eucalyptus family which approached 400 feet, but all authentic figures seem to indicate that these trees are far short of 400 feet and none are as tall as the tallest redwood.—A. D., San Francisco, Calif.




## Farmer-Machinist Backs Plan for Home Defense Work

YOU ought to push that idea mentioned in a recent issue, for giving home craftsmen something to do in this defense program. I have my farm work so organized that the farm just about runs itself for ten months in the year. I might as well put in my time in defense work, as I was a machinist in my younger days. There are more like me.—R. S. B., Gothenburg, Neb.

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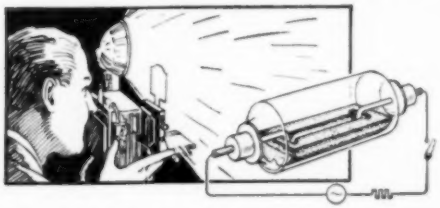
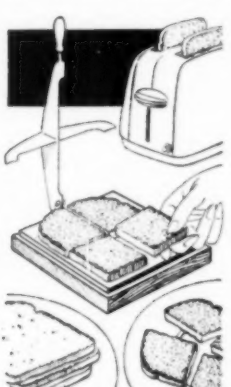
# With the Inventors

A PHOTOFLASH LAMP that can be used over and over again provides a new aid for photographers. A grooved trough in the base of its cylindrical bulb holds a thin ribbon of liquid mercury. At each end, electrodes dip into the fluid. When an elec-



tric switch is closed, a miniature explosion occurs within the bulb, turning the mercury into vapor with a flash of dazzling brilliance. The vapor then condenses and runs back into the trough, in readiness for the next flash. According to Chauncey G. Suits, who has assigned the invention to the General Electric Company, the bulb may be of glass or quartz, and the mercury trough of a refractory material such as alumina. . . .

NEEDED INVENTIONS, as compiled in a recent national survey, include: Heat-insulated dishes and coffee cups to keep food warm on the table; bottles made of transparent but unbreakable material; a plastic substance which would give a "warm" automobile wheel; a way to keep the points of collars from curling; a method of rainproofing hats; and a tobacco that leaves no ash. . . .



TASTY-LOOKING TIDBITS of toast may quickly be prepared by the housewife, with the aid of an ingenious slicer patented by Peter S. Larson, of University City, Mo. Cutting blades joined at right angles are hinged to the back of a block on which a slice of toast is placed. When a handle is depressed, the cutters divide the toast into four neat quarter slices. Curved ends of the cutting blades make them self-centering. . . . WHEN A YOUTHFUL RIDER mounts a hobby horse

*(Continued on page 20)*

# INVENTORS

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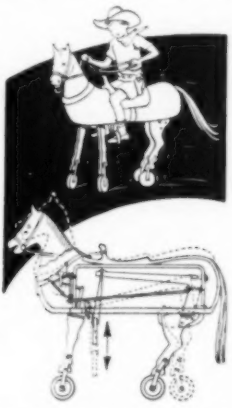
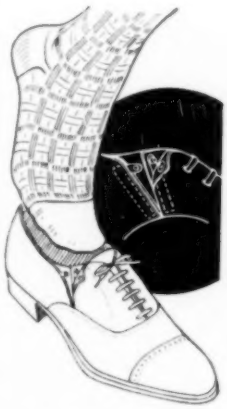
# With the Inventors

*(Continued from page 18)*

devised by José Ochoa, of San Francisco, he gets action. Instead of tamely rocking back and forth, the mechanical steed tosses its head and gallops away. Rising and falling in the stirrups operates the two hind legs that propel the realistic toy. Wheels on these legs normally are braked by the hoofs, but are given a forward kick and released by pressure on the stirrups. A return motion is provided by a coil spring, aided by the weight of the rider. To guide the mount, a tug at either of the reins turns the horse's head, and, with it, the front legs and their wheels. . . .



SHOES WHOSE LACES NEED NEVER BE TIED or untied are the invention of Fred S. Clark of New York City. The secret lies in a snap-button fastening at the side, which is invisible when the shoes are worn. Turning back a flap reveals the fastener and allows a metal latch to be released, giving the shoes sufficient flexibility to be put on or taken off. A protective lining keeps the metal parts from contact with the feet. Designs embodying the innovation in footgear have been worked out for men, women, and boys. . . .



WHAT MAKES YOUR CAR'S HYDRAULIC BRAKES go on when you press the foot pedal? If patent No. 2,226,487 comes into use, it will be "a brake fluid comprising 2 methyl pentane 2,4 diol as its major constituent, and added diluent the major part of which is constituted by at least one monohydric alcohol of from 4-6 carbon atoms."

*(Continued on page 22)*

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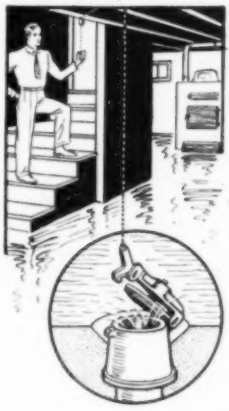
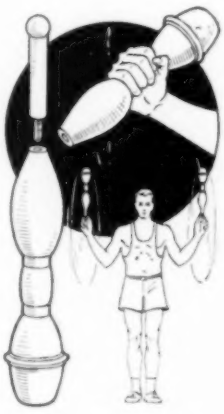
## With the Inventors

*(Continued from page 20)*

And stopping a car seemed so simple before! . . . A NEW SOLUTION to the problem of flooded cellars is offered by Olin E. Banker, of Wilkes-Barre, Pa. His invention, a remote-control valve that drains off the water into the sewer line, may be opened by a pull wire or chain from a cellar stairway or any other convenient point. When all the water has gone down the drain, the valve lid is closed and latched, providing a positive seal against any possible back flow into the cellar. Made of brass, the fitting is declared to be proof against corrosion and to last indefinitely. . . . AN INDIAN CLUB AND A DUMBBELL are combined in a single exercising aid by Nathan L. Paves of New York. For use as a club, the implement employs an auxiliary handle, securely fastened by a bolt to an open metal sleeve in its main body. This handle may readily be detached, however, converting the exerciser to a dumbbell shape. . . . ABRADING, ACETYLENE, ACOUSTICS, aeronautics and agitating begin a list of more than 300 major classifications into which the U. S. Patent Office sorts applications for patents. They are passed upon by 65 examiners, most of whom handle a group of subjects apiece. Such subjects as Carbon Chemistry, Radiant Energy, and Registers, however, occupy all of one examiner's time and part of another's. . . . DEDICATED TO THE FREE USE of the American public, a new spray for apple orchards has been patented





*(Continued on page 24)*

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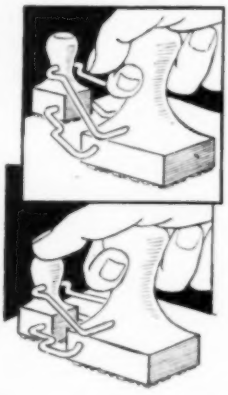
# With the Inventors

*(Continued from page 22)*

by L. E. Smith of the U. S. Department of Agriculture. It employs a chemical called phenothiazine, harmless to human beings but deadlier than lead arsenate to codling-moth "worms" or larvae that infest the fruit. . . . RUBBER STAMPS have long been used as labor-saving devices by Government employees, so it is only natural that a Washington, D. C., man, Charles B. Parker, should be the inventor of a device whereby two rubber stamps can be used as quickly as one. The two stamps are fastened together with wire braces set in rubber sockets so that one stamp is normally held slightly above the plane of the other. If only the impress of the main stamp is desired, the gadget can be pressed against the paper in the ordinary manner. If the print of both stamps is needed, a user slaps the main stamp on the paper a little harder, and the wire braces allow the auxiliary stamp to spring down onto the paper. Or the smaller one can be used by pressing it after the larger one is in place, as in the illustration. . . . READERS MAY PONDER whether a "Fun Provoking Novelty," U. S. Patent No. 2,227,343, should have the first word of its title omitted. Shaped like a shoe-polish box, with holes in its top, the device comprises "a mechanical manually released noise-making mechanism, and a casing for housing and concealing it." To make sure that the owner will be the life of the party, the device also includes "a bodily movable pan for containing liquid, the pan being adapted to catapult its contents in a predetermined direction in said casing, the casing being apertured for free escapement of the liquid." . . . PERMANENTLY COLORING STAINLESS STEEL, in tints ranging from light gold to dark brown, is made possible with an acid bath patented by Clements Batcheller, of Glens Falls, N. Y. To prevent the acid from etching the highly polished surface of the steel, "inhibitors" are added to the bath. The shade of color is determined by the length of the treatment.



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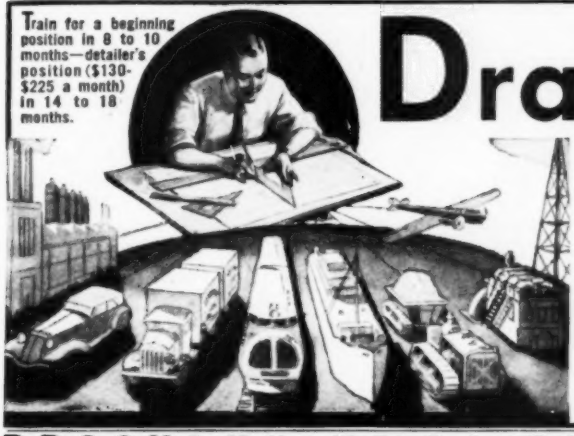

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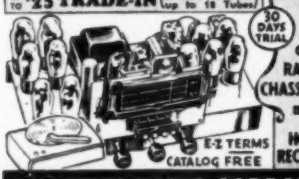

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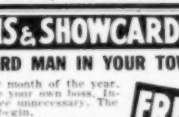

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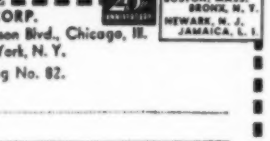

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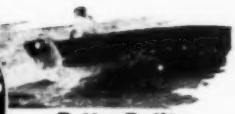

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ROLLS developed 6 or 8 prints including 5x7 enlargement, 25c coin. Prompt service. Gem Photo Service, 3355 W. 63, Dept. A, Chicago, Ill.

FINERFOTOS for 30 years. Roll developed and 16 prints, 25c. Many other offers. Satisfaction guaranteed. Finerfotos, Box 898-18, Minneapolis, Minn.

20 REPRINTS 25c. 100—$1.00. Roll developed 16 prints 25c. 5 x 7 enlargements 10c. 3—25c. Nordskog, 58, Maywood, Ill.

35MM Special. 36—$3\frac{1}{2}$x$4\frac{1}{2}$ prints, four colored 8x10 enlargement coupons, $1.00. Dick's Photo, M—1, Louisville, Ky.

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STAMP-SIZE. Gummed Photostamps reproduced from photographs, 100—59c. Wardwoode, SP-3, Wallingford, Conn.

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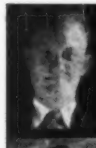

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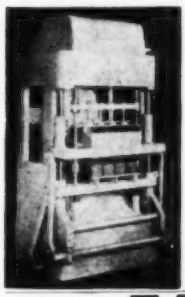

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# Flying Engineer

*Today's test pilot, whose job is to read instruments, not to miss a broken neck by inches—that's Herbert V. Shebat*

**By KENYON KILBON**

MAN of the MONTH

ALL THE DAREDEVILTRY and much of the risk have been eliminated from the profession of the test pilot. No longer is he a nerveless young man who flies by the seat of his pants and thinks up ingenious methods of risking his life. He is an engineer as well as a pilot, and makes a scientific analysis of engine performance in flight.

Today's test pilot does not start the tests—he completes them. Before he lifts a new plane into the air or takes off to try out a new engine, a remarkably thorough series of test "flights" has been performed on drawing boards, in wind tunnels, on engine blocks, and in pressure chambers. The pilot is not concerned simply with finding out whether the equipment will hold together; his purpose is to confirm under actual flight conditions the conclusions already reached by technicians on the ground, or to disclose some quirk which has remained hidden.

This change in the procedure of testing has, of course, developed a type of pilot different in most respects from the adventurous youth who formerly did the job. The careful reading of instruments in current tests is a far cry from the extensive use of intuition in the old days.

Herbert V. Shebat, engineering pilot for the Wright Aeronautical Corporation, Paterson, N. J., is a personification of the contrast between the hit-or-miss days and the methodical procedure of today. Now a test pilot for one of the world's leading aircraft engine manufacturers, Shebat studied engineering at the University of Minnesota before the World War, served with the Army Air Corps, and was a barnstorming flyer from 1924 to 1930, when he joined the Wright organization. Most of his hours in the air today are devoted to the testing of new appliances for engines already in production, and he has drawn on both his engineering and flying experience in putting Wright's Whirlwind, Cyclone, and Duplex Cyclone engines through their paces.

Shebat and his coworkers at the Wright flight-testing laboratory have their headquarters at the Caldwell-Wright airport, near Caldwell, N. J., about nine miles from the company's plants at Paterson. Since the function of the laboratory is to test engines rather than planes, the flying equipment is curious. It includes a Douglas biplane torpedo bomber built for the Navy five years ago, a fairly modern Curtiss Hawk 75 pursuit borrowed from the Curtiss plant for confidential tests, and a ten-year-old Pilgrim cabin monoplane. All, including the old Pilgrim, have been flown at more than 30,000 feet.

Shebat's job is as much varied as his planes. Today, for instance, he may be trying out an engine equipped with a new device for lowering fuel consumption. Fuel consumption is computed in terms of pounds a horsepower hour, and the rate of consumption, guaranteed in most modern engines is .5 pound.

When the engine to be tested is installed in one of the planes, Shebat's work com-

mences. His task is to establish a basis for comparison with other engines of the same horsepower. The most commonly used standard is the propeller-load curve, computed by making level test runs at specified altitudes with the propeller in a fixed position and with the power output varying on each run. Then the point is found on each run where the best performance in horsepower and speed were produced with the least fuel consumption.

In computing the propeller-load curve, he is interested chiefly in the torque indicator, the tachometer, and the fuel-flow meter.

The torque indicator registers in terms of inch pounds or foot pounds the force utilized in turning the propeller shaft at a given speed. The tachometer shows the number of revolutions a minute of the propeller, and the two together give the horsepower at which the engine is operating. On the instrument board the torque indicator is labeled BMEP, an abbreviation for "brake mean effective pressure," or the pressure exerted by the turning shaft on a stationary gear connected with it by a pinion. The pressure exerted against the stationary gear is countered by an equal pressure created by a pump in the engine, and thus the means for measurement is provided.

The fuel-flow meter shows, in terms of pounds an hour, the rate at which the fuel is being fed into the engine. If Shebat desires more precise information, he may use the volumeter, which measures a small quantity of fuel and feeds it to the engine while the observer times it with a stop watch. Work of this type has whittled the rate of fuel consumption to a point far below that of several years ago.

Some of the work which Shebat does can be handled on solo flights, but other experiments may require the assistance of a crew of three or four. One example is the successful attempt to reduce engine vibration. The old Pilgrim was the guinea pig in this series of tests, and the crew handled the oscillographs which were connected by pick-ups to various sections of the plane. Runs were made at different altitudes with varying power outputs, and the vibration was transformed through the pick-ups into electrical impulses which passed through a cathode-ray tube and became visible on a screen. The data contributed to the development of the modern motor mount, which cuts off from the body of the plane the vibration of the engine.

Most of the current tests at Caldwell are conducted at high altitudes, and, as Shebat will tell you, high-altitude work is "something that nobody who knows anything about it likes." The tests are, of course, largely confidential, but interest centers in the development of improved superchargers. On flights to more than 30,000 feet in an old open Curtiss Falcon observation plane, Shebat and his observers discovered data valuable in developing the two-speed supercharger, which produces moderate supercharging in low ratio for full power at take-off, and high supercharging in high ratio for flying in rarefied air.

More recently, experiments have been conducted with a multistage supercharger, which works on a sort of tandem principle, with one blower discharging into another. The chief problem in developing the two-speed type, Shebat reports, was the maintenance of equal pressure in and out of the engine. It was discovered in early tests that while pressure was maintained inside the cylinders, the pressure outside was not sufficient to insulate the ignition system, and a spark would jump to a cylinder which was not ready to fire. The problem was met by supercharging the magneto, too.

Shebat uses a camera which photographs the instruments during flights. In all three planes—provision has been made for the installation of a French-made Sept camera which can take either motion pictures or stills, and after each flight a permanent record of the performance is available.

The most interesting camera arrangement is that in the single-seat Hawk, where the machine has been mounted in a spare instrument board in the luggage compart-

A couple of Shebat's men make final adjustments in a motor he is about to test. Used in this work are a Douglas, a Curtiss Hawk, and an old Pilgrim

ment and is operated from the cockpit by a trigger on the control stick. Two feet in front of the spare instrument board is a mirror with an aluminum coating, and a reflection of the instruments is photographed. The lens is visible as a dark spot in the center of the board.

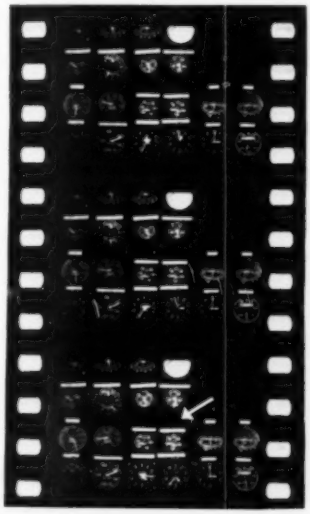
The lighting is supplied by two automobile headlight bulbs of six volts, mounted above the board out of the camera range, and the usual shutter opening is F/3.5. Shebat reports that his best results so far were obtained one day when he used a bulb exposure without realizing it.

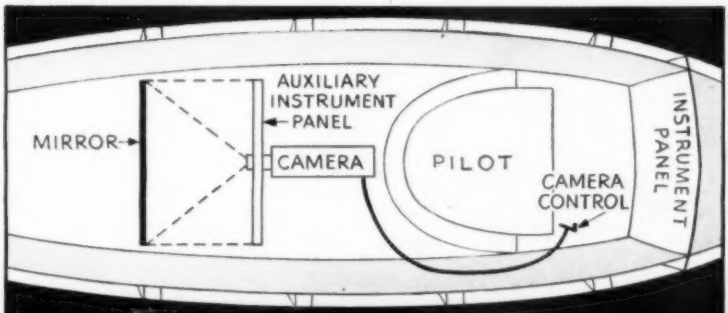
In the Douglas, more room is available in the observer's cockpit, and the camera is mounted four feet from the spare instrument board. To keep the two in the correct position in relation to each other, they are connected by metal rods which transmit the vibration from the board to the camera. The lighting arrangement is the same as that in the Hawk. At high altitudes, the low temperature interfered with the mechanism of the camera until an electric heating pad was wrapped around it.

Shebat's work is by no means without risks. Engine failures have been numerous, but he has always been able to land the plane safely. On one flight near Caldwell, the propeller and reduction gear dropped off, but since the airport was only four miles away and the plane was 6,000 feet up, he landed. The lost parts dropped a few feet from a woman in her garden. She was angry, not because she had nearly been killed, but because she was covered with dirt when the neighbors came running up.

Fuel consumption has been whittled far below the point of several years ago, by experiments with motors such as this one

**INSTRUMENT BOARD IS PHOTOGRAPHED,** either in still or motion pictures, to give a permanent record of test flights. Below is the camera set-up for a single-seater Curtiss Hawk. The camera is in the luggage compartment and is operated with a trigger on the control stick. Its lens, projecting through an auxiliary instrument panel, photographs the reflection of the panel in a mirror. The opening for the lens can be seen in the photographs at the right





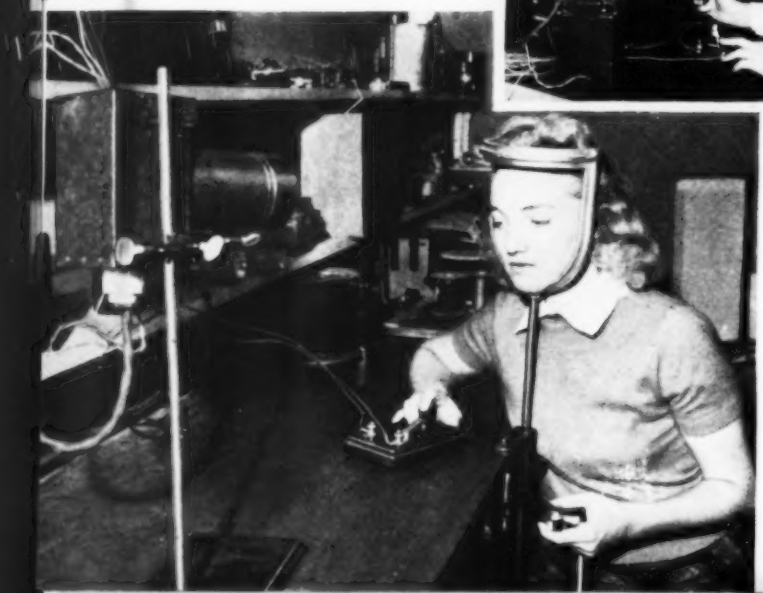
# Trapping the

Jean Warren under the red spotlight in a test of the effect of lights of different colors on her reactions

## QUIRKS OF COLOR

*Men prefer blue, women green. Poor children are attracted by red; richer ones by green. Red lights speed up human responses. Green lights retard them.*

Dr. Gilbert Brighouse, of Occidental College, Los Angeles, sounds a signal to be answered by Jean as soon as she can after hearing it. The electric chronometer times her



Jean is in another room with the spotlight throwing beams of changing colors upon her face. Under each color, as she hears the signal, she answers by pressing on a key

# Secrets of Color

Here is Jean in the green light. Her head is in a metal frame so she won't move out of the beam. Her reactions were quickest under the red light

HUMAN reactions to colors are being studied at various universities and other institutions. When the scientists have the data on which to base opinions, their findings will be influential in lighting and decorating schemes. Certain basic facts have emerged already. It has been determined that red is a stimulus and blue is soothing to most of the subjects.

In general, men seem to prefer blue, and women green. Children of poor parents find red the most appealing color, while those from wealthier homes like green better. Individual reactions, of course, are multitudinous in their variety and still largely inexplicable. Yellow may be the favorite color of one woman, while another finds exposure to yellow light nauseating.

Dr. Gilbert Brighouse, associate professor of psychology at Occidental College in Los Angeles, has been conducting tests there with hundreds of students of both sexes in a black-walled basement room, exposing their eyes and faces to various colors while recording measured responses. Eventually, he expects to test them with their faces shielded and other areas exposed to colors.

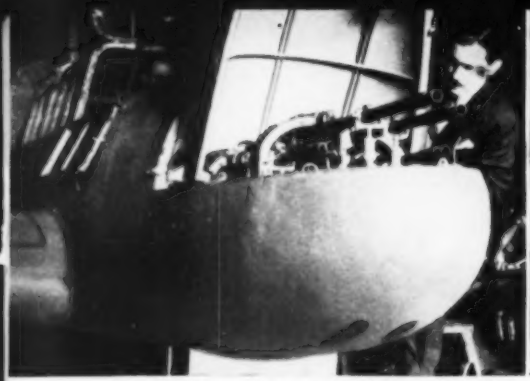
One test was repeated 455 times with each of 17 students. A spotlight sent a beam, first of one color and then of another, to the face of the subject. Dr. Brighouse sat in a room above. On his desk was a key which sounded a signal in the room below. He pressed the key; each student, as soon as he heard the signal, pressed a similar key, and an electric chronometer timed the action.

The quickest responses came when the red spotlight was on. Dr. Brighouse calculated that they came one-eighth faster than when untinted light was turned on. In the case of one youth, only one five-hundredth of a second elapsed between impulse and response; the time under normal light was sixteen one-hundredths of a second. A blue light retarded response to almost exactly the same degree as the red stimulated it.

Psychologists of Harvard University and the University of Chicago tested 2,500 children with six spectral colors and found that blue was the favorite. The second choice, green, was considerably behind blue, but red was a close third. Violet, yellow, and orange were chosen in that order. Similar tests were made with somewhat older children and it was found that green now was the favorite color, with blue, violet, orange, and yellow chosen in that order. It was during this experiment that the fact emerged that poorer children preferred red, while wealthier ones chose green first.

At the University of Kansas 343 students were tested to determine their preference in colors. Spots of blue, green, red, amber, and clear light were thrown on a ground-glass screen in succession, and then in combinations of two colors each. In the single colors men chose blue, and women green. Red was the second choice of both. In the combinations the men preferred red and blue and the women chose the clear light with the green.

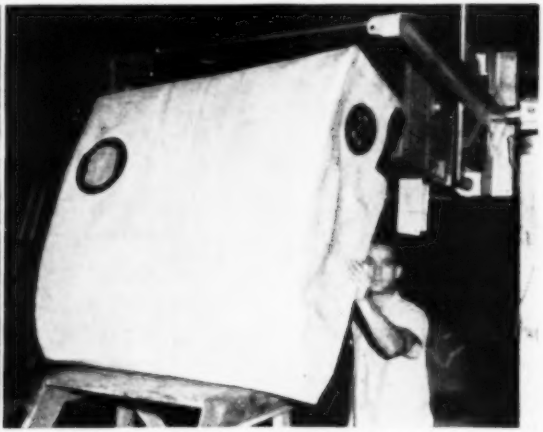
In an effort to make the surroundings of patients at the New York Psychiatric Institute and Hospital as pleasant as possible, Dr. S. E. Katz examined them as to their color preferences and found that the men chose green, and the women red. Carrying the examination to those who had been inmates of an asylum for three years, Dr. Katz found that blue was chosen by the majority of both sexes. Among patients of still longer standing, orange was the favorite color.



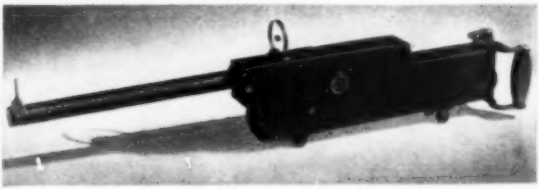
From the five machine guns and two cannon the British found on this Messerschmitt 110 . . .

the United States has learned to use heavier armament on planes like the Airacuda (above)

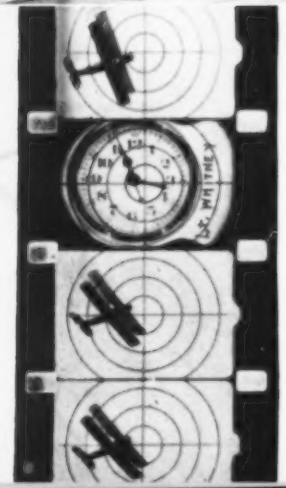
War has proved that self-sealing gas tanks are essential. Here is one from a Nazi plane . . .



and this is the type that the United States is installing in combat planes of the latest model



The Fairchild CG16 has a spade-type trigger at rear



The U. S. is following Britain in placing camera machine guns in actual fighters, to record fights

Left, 16-mm. film from a camera gun. Circles and cross hairs are on a glass plate between film and shutter. The clock is pictured after each burst of fire

Main camera mechanism comes out of a door at top of the case without interfering with adjustment

# What has America learned from the war?

By CARL DREHER

ABOUT the busiest students in the United States now are the officers of the Army and Navy. The battleground of Europe is their university. Like other technicians, they have to keep learning as they go, and they learn best by experience.

Now, if you are running a subway, you are running it all the time, but if you are in the military profession you have to wait for a war. After all the studying of past wars, after all the planning and preparing, you still have to learn by fighting—either your own or somebody else's. Somebody else's is less expensive.

The general lessons of the present and recent European campaigns are not new, but they bring out new phases of principles which were known to all educated soldiers. One is the vital necessity of close coördination of all branches, under unified command. If there was any miracle about the victories in Norway and Flanders, is was in the skill with which the Germans welded their specialized arms into a single fighting machine. It was a remarkable demonstration of teamwork in combat against opponents who were not prepared and drilled in anything like the same degree. The results were conclusive.

It was not solely a triumph of machines. Mechanization is extremely important, but everything depends on the manner in which the forces are used. The rout of the mechanized Italian forces at Guadalajara in the Spanish war by relatively unmechanized troops (an episode repeated with variations early in the Greek campaign) shows that machines as such do not win a war. Machines magnify both striking power and vulnerability. On the wrong terrain or in bad weather, or under bad leadership, a mechanized army can be led into disaster faster than one equipped only with the traditional arms.

Like Britain, America now equips planes with power-operated turrets, hydraulic, pneumatic, or electric

The "secret" of the effective use of mechanized ground forces lies in finding a weak spot and hitting it for all it is worth. The principle is older than mechanization; Sheridan used it in the Civil War with cavalry. He massed his cavalry in one place and broke through, and he had the knack of picking the right place. Before his time the tendency was to distribute cavalry along a wide front, just as the British and French mistakenly used their tanks and other mechanized units in the present war.

For all their stress on mechanization, the Germans had nine or ten infantry divisions for every "panzer" division. When they achieved a break-through they had the necessary infantry power to keep and extend the opening. The mechanized forces, once they got through, were able to work havoc behind the enemy lines, for they were virtually self-sufficient, forced neither to return to their bases for supplies nor to rely on communication lines. The necessity for self-sufficiency of fast-moving mechanized forces is one of the important practical lessons from what happened in France.

Aside from such general conclusions as these, there are indications that the functions of some of the arms will be different in the future. One factor about which American soldiers are speculating is the use of the engineers as a combat arm. Of course, engineers have always been prepared to fight, although their primary function is to make routes passable for their own forces and impassable for the enemy. The Germans, however, used engineers deliberately for some of their toughest fighting—substantially as shock troops. The invasion of Belgium was led by a battalion of engineers, and fortifications such as the Belgian Eben Emael, which were virtually invulnerable to artillery fire, were reduced by engineer combat units with explosives. Besides explosives in

Uncle Sam has long used heavy bombs such as Europe's war has proved effective. This 2,000-pounder will be dropped for practice

After careful study of bombs and shelters in war, Americans have designed a new concrete pillbox which can be built in five hours

great quantities, these engineers carried rifles, machine guns, hand grenades, flame throwers, scaling ladders, crowbars, long poles, smoke candles, and about every other portable assault weapon that can be imagined. They closed in by taking advantage of shell craters which the artillery made for them. The occupants of the fort were unable to reply effectively because the German artillery kept up a continuous fire on the ports and turrets. Finally the engineers were able to get right up against the walls of the fortress and to blow up turrets and doors with planted explosives.

Next to the airplane, the tank is the chief new weapon both of the first World War and the present one. And as far as this war is concerned, the heavy tank is the one to watch, not the light tank. One military observer remarks that the effectiveness of the heavy tank as a break-through weapon was something of a surprise to soldiers as well as to civilians. Except for Germany, he says, after the last war the nations deluded themselves into the belief that swarms of tankettes would be effective for open warfare, and this while they were building fortifications such as the Maginot Line, the Mannerheim Line, and the Czech Sudetenland forts, against which light tanks had about as much chance as a tack hammer against a bank vault.

This commentator believes that the Russians could have breached the Mannerheim Line at considerably lower cost with large tanks than with the artillery, planes, and masses of men they eventually used. They started with thin-skinned medium-weight tanks, which proved ineffective. In contrast, the Germans on the Western Front relied on heavily armored tanks from the outset. According to one report, these tanks weighed 70 tons apiece and were armed with 77-mm. or 155-mm. cannon, and flame throwers. The Germans have not provided samples, and one can only speculate as to the actual weight and armament of these machines. The only thing certain is that they were heavy and numerous enough to achieve the objective, and that they were fast for their size. Weight alone was not a determining factor. It is known that the French threw into the action some twenty 70-ton tanks of an obsolete design, and these were hopelessly ineffective against the faster German machines.

The monster tank has two missions (military men are fond of that word)—to break through, and to repel enemy tanks. It has to be as agile as its size will permit, climb well, and span broad ditches. It must be heavily armored, since antitank artillery is constantly increasing in effectiveness, and calibers as high as 75 mm. may be used against it. Its own armament depends on its purpose. Against ordinary fortifications it may carry two or more 75 mm. or 155-mm. cannon. For close-in protection and against infantry, it uses machine guns. In

addition to this arsenal, it has need for an antiaircraft gun as well.

Naturally, it is not an extremely fast machine. Small tanks are fast, and if outgunned they can always make a run for it. The heavy tank must shoot its way out. But that is a slight disadvantage. The chief trouble with these heavy tanks is in transporting them before they go into battle. Since few highway bridges can sustain their weight, they must travel by rail. That limits their width in most countries to 10 feet 4 inches, and height to 14 feet 5 inches above the rails. They can be carried on flat cars if their weight is not over 80 tons, but a better method is to equip them with rail trucks which are a part of the tank itself, so that several can be drawn in tandem by one locomotive, or they can move on rails under their own power.

An example of the adaptation of old weapons to new conditions under stress of necessity is the use of the 75-mm. gun against tanks by the French. Since a tank is fairly fast, it is necessary to swivel the piece rapidly to keep up with the target. All that this involves is the addition of a circular metal platform with six-inch metal prongs on the under side. This is carried separately on a caisson. To operate against tanks, the crew throws the platform on the ground and jumps on it to imbed the prongs. On its upper surface the platform has a flange which forms a circular track for the wheels of the gun. The trail is shifted by one or two members of the crew. Used in this way, the 75-mm. gun did fairly effective work as a substitute for the standard 47-mm. A. T. gun, with which the French were none too well equipped. It was no more than an improvisation, but one of some interest to the military student.

The United States has no big tanks on hand, but it is understood that a heavily armored model of 50 or 60 tons is about ready for field testing. The fact that we do not have hundreds or thousands of such juggernauts ready to go into action is no cause for alarm. The likelihood of our needing them for use at home is extremely remote. If they should ever be called on, the Army will have them and know how to use them. It has kept abreast of military developments all over the world and has never subscribed to the now discredited theory that tanks and other mechanized units should be "encadred" within larger units. Our tacticians favored the independent, synchronized-action method before it was proved in the field by the Germans, and it is being taken into full account.

The performance of American aircraft in

The parachute land mine, the latest in destruction, floats gently down and explodes at the surface, instead of digging a crater and wasting much of its force underground. It is deadly to troop concentrations

The Germans' devastating use of tanks has set American plants to building the monsters at maximum speed. Both in factories . . .

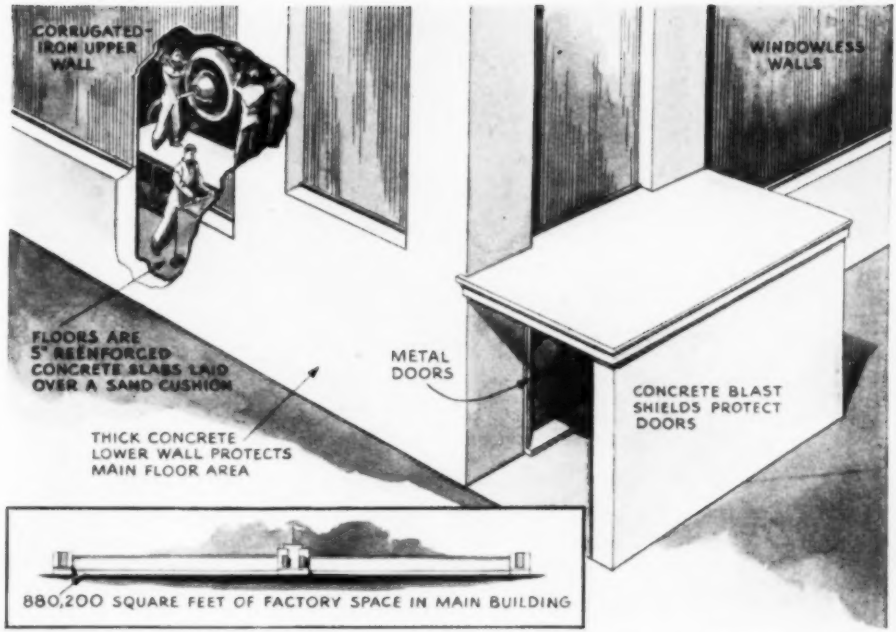
. . . and in the field, the United States is motorizing with all its might, and learning the tactics by which motors win battles

England recently has been severely criticized. These criticisms, in so far as they relate to models supplied during 1940, are in large part justified. The planes that have gone over have been fast, highly maneuverable, and well built, but most of them have been underarmored and undergunned, sometimes complex in operation, and not equipped with important accessories of modern aerial warfare such as self-sealing fuel and oil tanks.

It should be realized, however, that every new model of anything, whether it is a radio receiver or a milk can or an airplane, is found to have things the matter with it when it gets into the field. That is bound to be doubly true of such a complex, nervous, and changeable business as air fighting. Many basic questions of aircraft design are not yet settled. Take the matter of the air-cooled radial engine and the liquid-cooled engine. The British prefer the latter for pursuit planes, but there are plenty of arguments on the other side. The air-cooled motor is being produced in quantities; it is the type used by the commercial airlines. It warms up faster—any motorist can appreciate what that means in dependability—and by the same token it has a longer life. It is lighter. The fire hazard is slighter. There is no danger of loss of cooling fluid through gunfire. All these considerations may now have to go by the board as far as pursuit planes are concerned, but the probability is that both air-cooled and liquid-cooled motors will continue to be used to power military airplanes.

One other point should be noted. The planes on which the United States relies for immediate protection, especially the naval types, are highly satisfactory for the purpose for which they were designed. The air defense of the United States relies primarily on the bomber. The pursuit ship plays a secondary part. Pursuit and interception are of far more importance to the British than to us. One experienced American Army officer sums up the situation as follows: "It must be remembered that the defense of the British Isles is actually a 'special operation.' American planes were not designed for this. Our large-view problem of military aircraft is quite different from the pressing situation in which the British now find themselves, and it would be a grave mistake to base design entirely on the momentary needs in the defense of the British Isles."

None of this alters the fact that with the information now coming over from England the United States will make as much progress in combat-plane design in a year as in two or three years of normal develop-


CORRUGATED-IRON UPPER WALL
WINDOWLESS WALLS
FLOORS ARE 5" REENFORCED CONCRETE SLABS LAID OVER A SAND CUSHION
METAL DOORS
CONCRETE BLAST SHIELDS PROTECT DOORS
THICK CONCRETE LOWER WALL PROTECTS MAIN FLOOR AREA
880,200 SQUARE FEET OF FACTORY SPACE IN MAIN BUILDING

America's first "black-out" factory is being built on the West Coast by North American Aviation. Another airplane factory, at Dallas, Tex., will be camouflaged with an 18-hole golf course painted upon its roof

ment. The same is true of the operation of fighting planes. The power-driven gun-turret is a case in point. A turret in an airplane is a kind of universal joint which permits aiming guns in almost any direction. The United States had several types under development before the question of aid to Britain came up. But the British turret which became available to American designers in October, 1940, is very good, the result of several years of experimentation, and no doubt it will influence the design of American turrets. It is hydraulically operated. There are also pneumatically, electrically, and manually operated turrets. One thing that should be guarded against is the installation of more than one type in a given plane. Maintenance difficulties are quite enough without mixing up several types of mechanism for the same job.

One advantage, from a military standpoint, of the present tie-up between British and American aircraft technicians is that our people get accurate information on German types. German planes brought down in England can sometimes be repaired and flown almost with their original performance characteristics. What is perhaps even more important, the results of large-scale air fighting can be obtained for the development of American aircraft. Finally, some idea can be had of what the Germans are going to spring in their new models.

One of the best of their current types is the Messerschmitt 110. Its design and performance are now accurately known, since the British have several of them. It is an all-metal plane powered by two 1,150 h.p. motors, liquid-cooled. The speed is 365 m.p.h. at 19,000 feet. It mounts five machine guns and two 20-mm. cannon. None of these fires through the airscrew disk, so that there is no limitation of the rate of fire on that account. All the forward armament is concentrated in the nose—four of the machine guns and both of the cannon. The fifth machine gun covers a 120-degree arc rearwards. There is a long-range version of this model which dispenses with the cannon; this is the one which has been extensively used for bombing as well as for escort and pursuit. It can carry two 550-pound bombs in the center section.

The results of air fighting to date indicate that the smallest gun which can damage a plane seriously is the .50 caliber size. Rifle-caliber bullets are effective only against personnel, and as armor protection improves it becomes more and more necessary to damage the plane rather than its occupants. There *(Continued on page 220)*

# New X-Ray Camera "Fingerprints" Pearls, Distinguishes Natural from Cultured

Dr. A. E. Alexander using his special apparatus to X-ray pearls

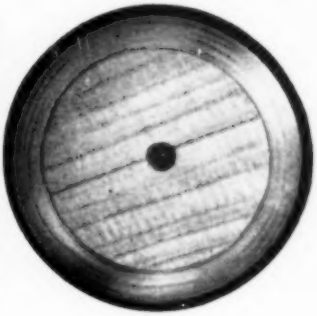
IDENTIFICATION of pearls by X-ray pictures is now almost as definite as that of humans by fingerprints. Dr. A. E. Alexander, of New York, who developed this method, also uses X rays to determine whether pearls are natural or cultured. Natural pearls are like onions in that they are made up of concentric spheres. Cultured pearls are merely pearl coatings over mother-of-pearl beads which were placed in the shells of living oysters, yet they so resemble natural pearls that even experts sometimes are deceived. A cultured pearl can often be bought for $2, whereas the natural kind may be worth thousands.

Fluoroscopic examination of a pearl with the apparatus used by Dr. Alexander will quickly reveal its nature. Because the internal structure of each natural pearl is a little different from that of any other, radiographs can be used for positive identification.

A necklace inside the hood is being examined fluoroscopically

Above is a natural pearl, entirely of concentric spheres. Below, a cultured pearl, built up around a bead

This device moves the necklace under the X-ray, a gem at a time



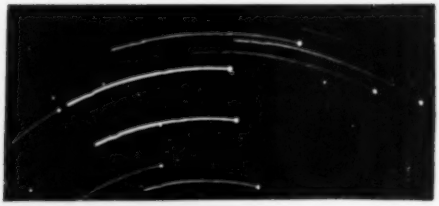
# Homemade Planetarium

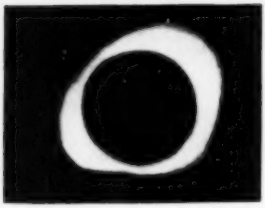
## Amateurs Build a "Stellarium" from $250 of Odds and Ends

A "STELLARIUM" built by three hobbyists of Pittsfield, Mass., at a cost of only $250, puts on an astronomical show that draws hundreds weekly to the city's Berkshire Museum. Spectators watch the moon, planets, and comets pass in review upon a starry sky. Interspersed views give them the thrill of looking at the same spectacles through the eyepiece of a giant telescope. Finally they see a total eclipse of the sun, during which the stars appear and the solar corona flames out in full brilliance.

By substituting ingenuity for money, Willard F. M. Gray, 28-year-old inventor of the stellarium, evolved the simplest possible substitute for big planetarium instruments costing tens of thousands of dollars. Two of his fellow workers at the General Electric Company, Stephen C. Leonard and Giles W.

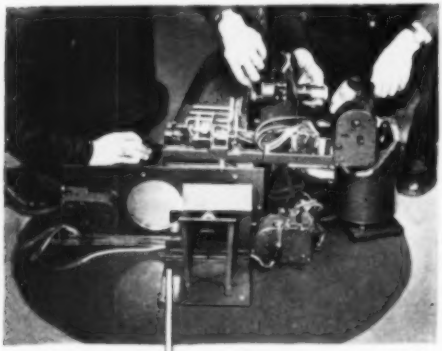
Giles W. Bradshaw, Stephen C. Leonard, and Willard F. M. Gray with the planetarium they built for the Berkshire Museum at Pittsfield, Mass. Gray is at the compact control panel



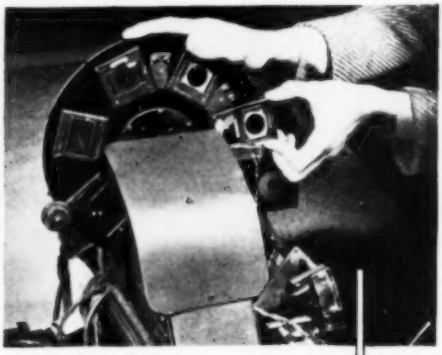


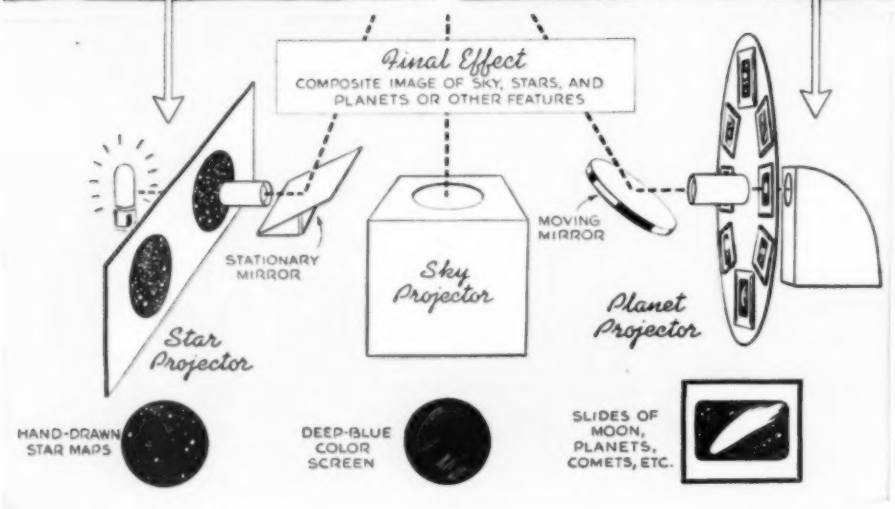
At upper left, a comet streaks across the planetarium sky; above, stars circling; far left, Saturn with its rings; left, solar eclipse seen with corona

Below is a close-up view of the star projector which throws maps of constellations on the ceiling, as shown in the diagram at bottom of the page



And this is the planet projector. A rotating disk made from a phonograph-record blank holds 35-mm. slides of pictures of important celestial objects





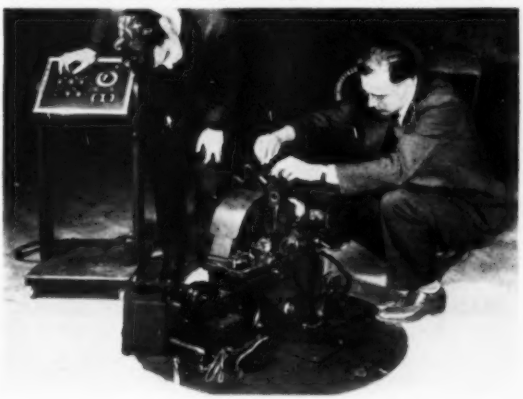
Bradshaw, helped in the spare-time work of constructing the machine and perfecting its design. The Berkshire Museum paid for materials. The result is a precision-built instrument so compact that it fits within a drum-shaped case only 40 inches in diameter. Through a maze of electric relays and wiring, an operator at a control panel puts it through its paces, while a lecturer with a flash-light pointer describes the celestial scenery.

Complex as it appears, the stellarium consists essentially of three projectors, which form a composite image on the ceiling of the exhibition room. A sky projector, which paints the daytime sky blue, dims for twilight or night effects. A star projector adds star maps of the northern and southern hemispheres, prepared by Stewart Greene of the museum staff. After charting all stars down to the fifth magnitude, he sprayed in the Milky Way with India ink and a Flit gun. A camera negative transformed each chart into white stars on a black background. Shifted to the proper latitude on a sliding carrier, the motor-driven star maps rotate in ball bearings to simulate the apparent motion of real stars. Likewise a motor-driven planet projector, with a turning and tilting mirror, directs to any part of the heavens a prearranged succession of slides. Some are black-and-white photographs taken through Mount Wilson's 100-inch telescope; others reproduce expert astronomical paintings in full color.

Odds and ends helped keep down the cost of the instrument. A ten-cent mirror throws star images on the sky. Three electric-clock motors, and three motors for furnace damper regulators, operate moving parts. Forced draft from a furnace fan cools the hot projectors. A blank phonograph recording disk serves as the slide-carrying disk of the planet projector. In one place, a $15 photographic enlarging lens replaces a special lens that would cost $120.

Stewart B. Greene, left, with an original layout for a star map. Leonard, at right, holds a 35-mm. planet-projector film

Putting the cover on the drumlike case which houses the projectors. Note the openings through which light beams pass



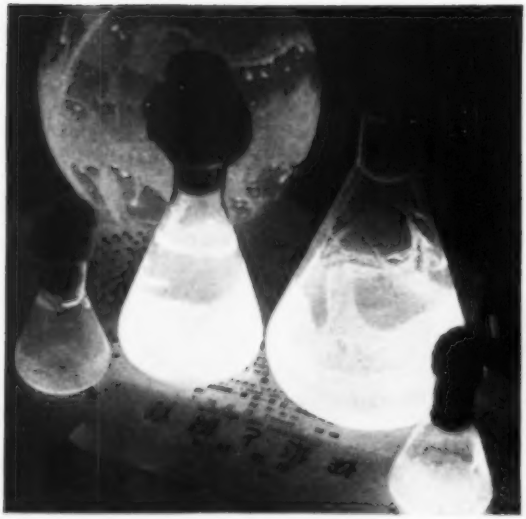
Leonard inserts slides in the planet projector, while Gray looks on from the control panel with its 11 switches

Dr. S. O. Coolidge with some "butcher shop" rock formations resembling meats. Below, a squaw with a papoose

## Hobbyist Collects Odd Figures in Stone

WEIRD mineral formations deposited centuries ago on what was once the bottom of a salt sea in Imperial Valley, and collected for their grotesque resemblance to living and imaginary creatures, make up the front-yard museum of Dr. S. O. Coolidge, of Thermal, Calif. "Joe Louis" shadow-boxes the Seven Dwarfs, and Old King Cole and "Mae West" vie for attention.

## Cold Light from Cuttlefish Is Put Up in Bottles

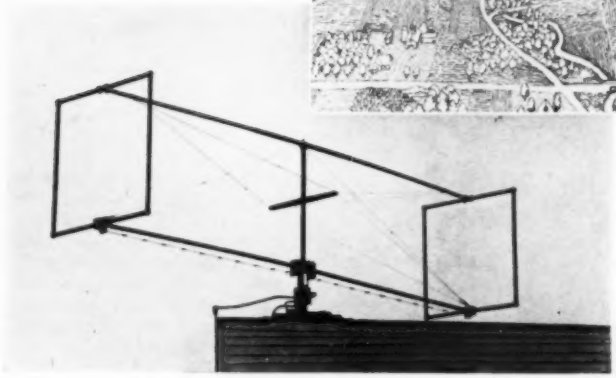


Luminous liquid containing bacteria from cuttlefish, as photographed by its own light with one-minute exposure. At right are test tubes containing the bacteria culture

GLASS decanters filled with liquid that gives off enough light for reading a book have been developed by a Japanese bacteriologist. The liquid is prepared from a culture resulting from special treatment of bacteria removed from the surface of cuttlefish. The culture yields "cold light," and is said to have a useful life of from six months to three years if it is not exposed to high temperatures.

## Directional Radio Worked in Reverse To Locate Planes

To locate plane, stations "A" and "B", on the airway, and "C" and "D", off the track, simultaneously take bearings



At left, the metallic frame antenna which is rotated to find direction of plane's signals

THE PRINCIPLE of the radio compass has been applied in reverse by United Air Lines engineers to develop a device enabling ground crews to locate planes in flight without computations by the pilots. Each of two or more stations is equipped with a metallic frame antenna, rotated by an electric motor. Short-wave signals transmitted by the plane are picked up, and since they are strongest when the antenna points to the plane, its direction from the station can be determined. With this information from at least two stations, the position of the plane can be fixed by triangulation. If possible, four stations are used, two directly on the airway and one on either side of it. The pilot need not even know his position is being plotted.

Dr. Shotton and the gun he invented to save anglers' energy

## "Fish Gun" Replaces Rod for Casting the Lure, Sparing Angler's Arm

YOU DON'T have to know anything about casting, nor need you exert yourself too much, in order to catch big ones with a "fish gun," according to Dr. J. C. Shotton, of Cleveland, its inventor. The pistol contains a reel and line. Bait the hooks or put on a lure, aim where you think the fish is, and pull the trigger. Now, if the fish will simply be obliging enough to hook himself, all you have to do is pull him in by winding up the line with a reel which is built into the pistol just above the butt, as shown in the illustration at the left.

# A $850,000,000 DRINK

*Do you know what happens when you turn on a faucet? It's an amazing story of engineering and chemistry*

FIFTEEN THOUSAND men are burrowing northward from New York City for 85 miles to insure an ample supply of pure water for the city. Their "jackhammers" are idle only during blasting operations. Night and day they work, sometimes half a mile below the surface, detonating 20 tons of dynamite a day, and each day removing from the bore enough rock to cover an acre to a depth of six feet. They advance about a mile a week.

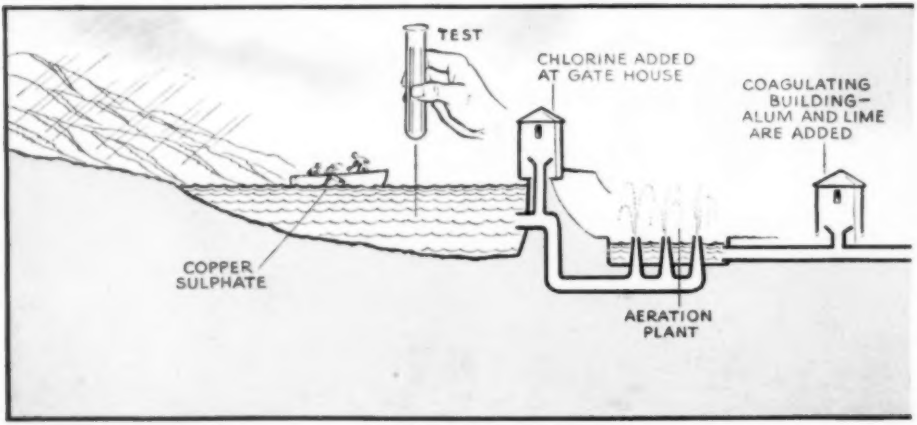
At its southern end this tunnel through the rock will be 19½ feet in diameter. It will cost $298,000,000 and by 1944 or 1945 it will be delivering 170,000,000 gallons of water daily from the Rondout Valley in the western Catskills. When that day comes, the hard-rock men will be toiling beneath mountains still farther to the north, burrowing 35 miles more to the headwaters of the Delaware River, which are to furnish 340,000,000 gallons more a day for New York.

The completion of that operation will add another marvel to the far-flung water-supply system of New York, already the admiration of half the world. It takes a plant of no mean proportions to supply the needs of 7,380,259 persons whose close proximity to each other leads to a highly complex system of existence.

New York now uses 900,000,000 gallons of water daily, and for 25 years has been getting most of it from the Catskill region. Tunnels and pipe lines have been carried 120 miles to bring the water to the city. The reservoirs, pumping stations, and aqueducts cost $553,403,000. Daily consumption now is only 90,000,000 gallons short of the dependable daily supply from the existing system and the rate of consumption continues to advance rapidly. At the end of each year, for some time, about 20,000,000 more gallons a day have been used than at the end of the preceding year.

The daily water use of the city is figured at 120 gallons a person, but more than half of any individual's 120 gallons is used without his being conscious of its service to him. It is estimated that the average actual use of water per person per day is about 52 gallons. Forty-five percent is used for flushing the toilet, 30 percent for bathing, six percent in the kitchen, five percent for drinking, four percent for laundry, three percent for washing, three percent for sprinkling the lawn or garden, three percent for miscellaneous uses, and one percent for washing the automobile.

The most important water consumer in the city, however, is the New York Steam Corporation, which pipes steam beneath the streets to its customers. Every day this corporation uses 5,000,000 gallons of water. Air conditioning, now in wide use, requires huge quantities of water. Breweries, laundries, manufacturers of soft drinks, ink manufacturers, swimming pools, hotels, ice



# OF WATER

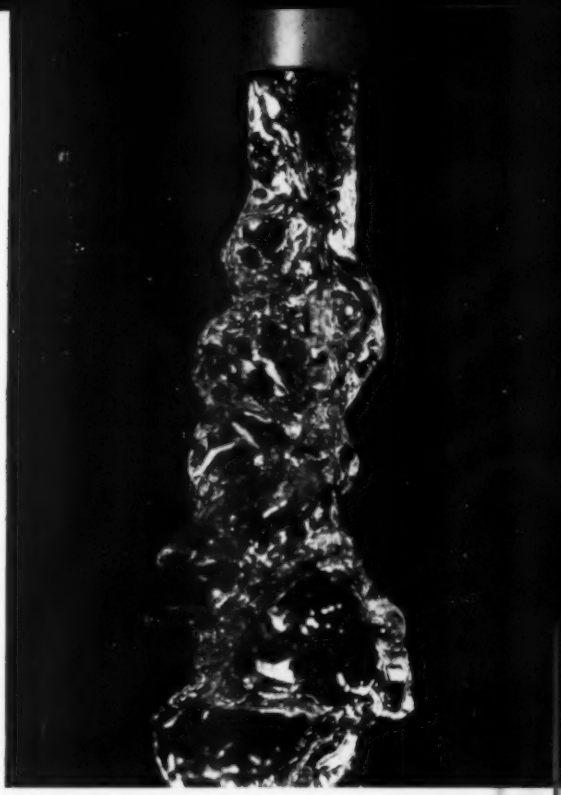
plants, and a host of other commercial enterprises draw heavily on the reservoirs. The Hotel Pennsylvania uses 205,000,000 gallons of water annually and pays $41,000 for it, the city's charge being $200 for each million gallons. The city's revenue from water taxes is about $38,000,000 a year.

The vast water supply system grew, of course, as the city grew, but in the last century, which has seen such rapid growth in population as to necessitate a complicated supply system taking years to construct, foresight and engineering ability became essential. So far they never have failed, although there have been some close calls.

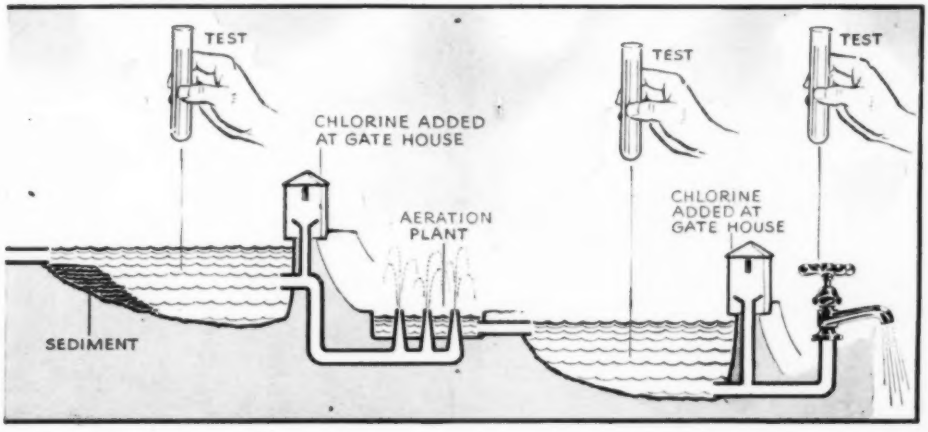
In the days of Dutch occupancy wells were in general use, with casks of water from springs drawn through the street and peddled for a penny a bucket. Aaron Burr's Manhattan Company made the first serious attempt to pipe water through the streets, and its ancient wooden pipes occasionally are unearthed today, still in a remarkable state of preservation.

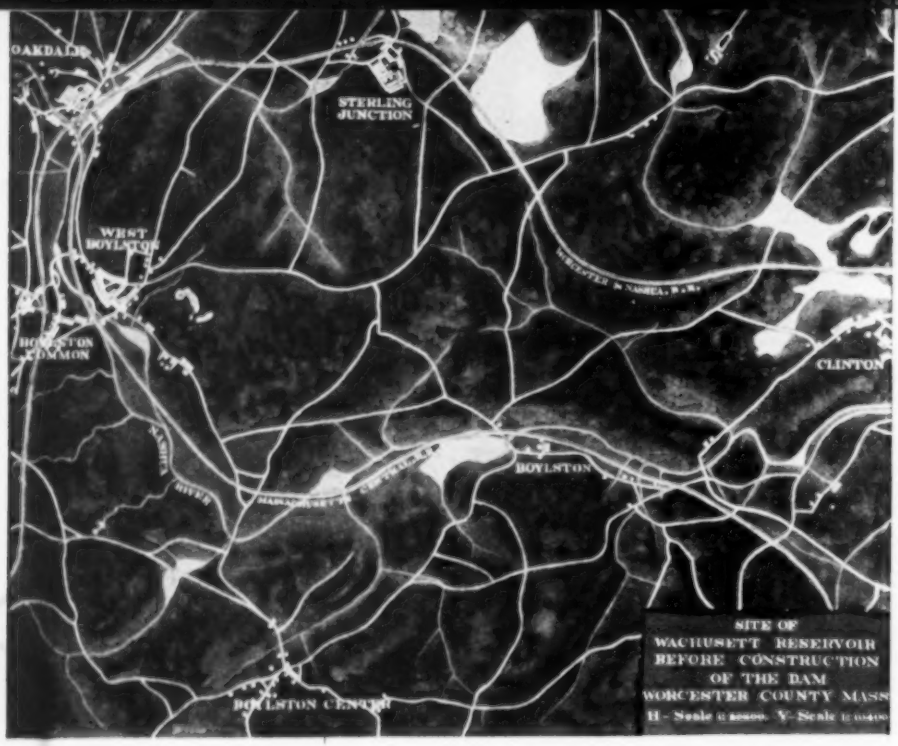
It was in 1832, after a cholera epidemic, that construction was started on a 35-mile aqueduct to bring Croton River water to New York. The enterprise was completed in 1842 and, it was thought, would suffice the city indefinitely. With no reënforced concrete construction or steel pipes, the Croton water had to be brought down in a gravity line which kept to the surface. When the water reached the Harlem River, it had to be carried across on High Bridge, there being no adequate means of confining it in a siphon beneath the river. Forty years later, when the second Croton aqueduct was constructed, a seven-mile pressure tunnel was bored for it.

It was when the reënforced Croton system

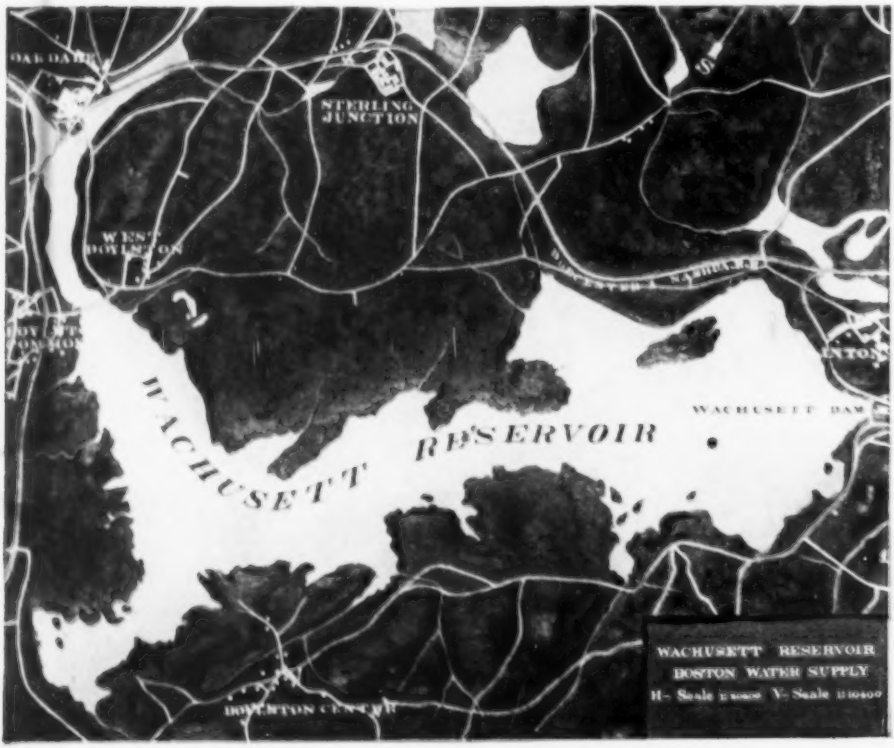


This looks like glass or ice, but it's just plain tap water photographed at 1/50,000 sec. by Prof. Harold E. Edgerton as it streamed from a faucet





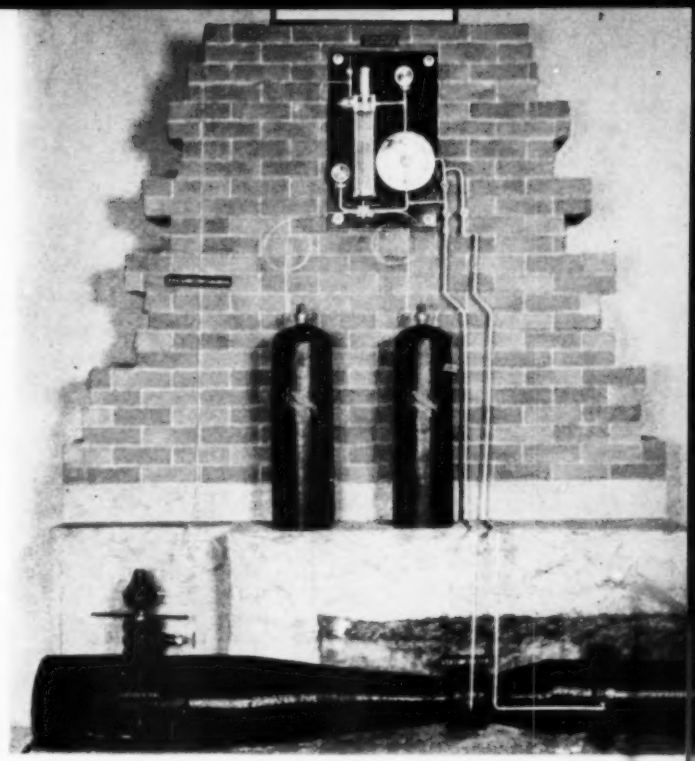

How a dam creates a reservoir: Above is a map of the site of the Wachusett, Mass., reservoir before flooding; the map below shows the same area after the dam had transformed the valley into a lake. This is part of the water system developed for Boston, Mass., by J. Waldo Smith

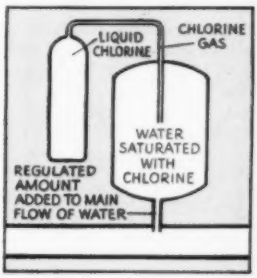


was to be further enlarged that New York first called upon J. Waldo Smith, the engineer who became its Moses, smiting the rock in the wilderness with his staff.

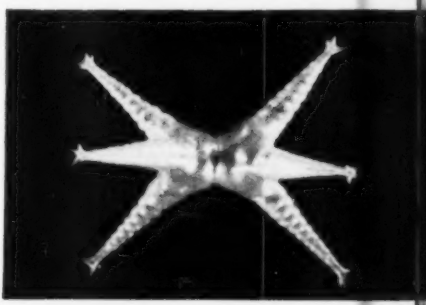
Water-supply systems had a fascination for Smith from his youth. At the age of seventeen years he became chief engineer of the water works in his home town of Lincoln, Mass. It was, as he used to describe it, a "one-lung" pumping plant, but it became the apple of the youthful Smith's eye and he kept it working as it never had worked before. During summer vacations from his studies at Massachusetts Institute of Technology, he worked for the Holyoke, Mass., Water Company, cleaning turbines and handling other messy jobs. In 1890, three years out of college, he became resident engineer of the East Jersey Water Company and supervised the construction of four reservoirs and dams for the city of Newark. He built a $7,500,000 water system for Jersey City and a purification plant for Little Falls, N. J., which was a model for its day. He helped develop the water systems of Boston, Denver, and Providence.

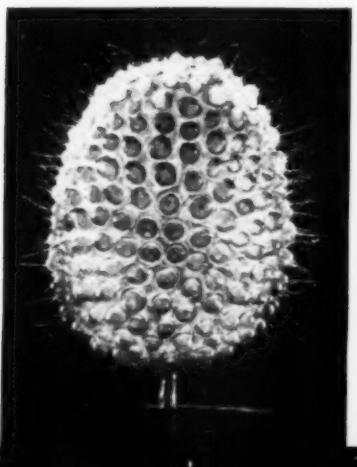
In 1903 he was called to the aid of New York City and worked on the Croton Dam, the dam and reser-



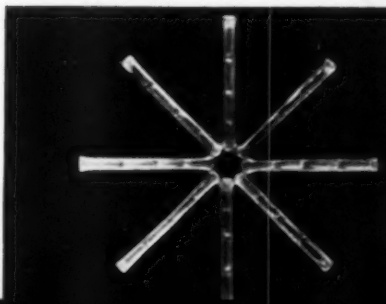



Before water reaches your faucet it has been aerated and chlorinated. Apparatus for injecting chlorine is above





Large models of four forms of microscopic life found in water. The staurastrum and diatom top and center, at right, are tasteless while the asterionella, right, and uroglena, left, cause strong tastes



voir at Cross River, and the Jerome Park Reservoir, all parts of the Croton watershed, then being taxed almost to its capacity. In 1905, when the situation became alarming, Smith was made chief engineer of the Board of Water Supply and told to go find some water. He found it in the Catskills, and the Esopus Creek was the center of its shed. A dam could be put up at Ashokan, said Smith, and an aqueduct built to bring the water to New York. The cost was estimated at $200,000,000.

In four months he had completed 3,000 miles of surveys. The work went ahead rapidly. Villages, farms, highways, and eleven miles of railroad were wiped out or transplanted and the work was completed with a saving of $9,000,000 on the original approved estimates.

The great aqueduct which brings the water drives straight through mountains and beneath the mighty Hudson River. The siphon beneath the river from Storm King to Breakneck Mountain was a colossal undertaking. Apparently bottomless silt formed the river bottom at that point, and test borings were made for two years before solid rock was found. The Catskill water is brought beneath the river at a depth of 1,100 feet.

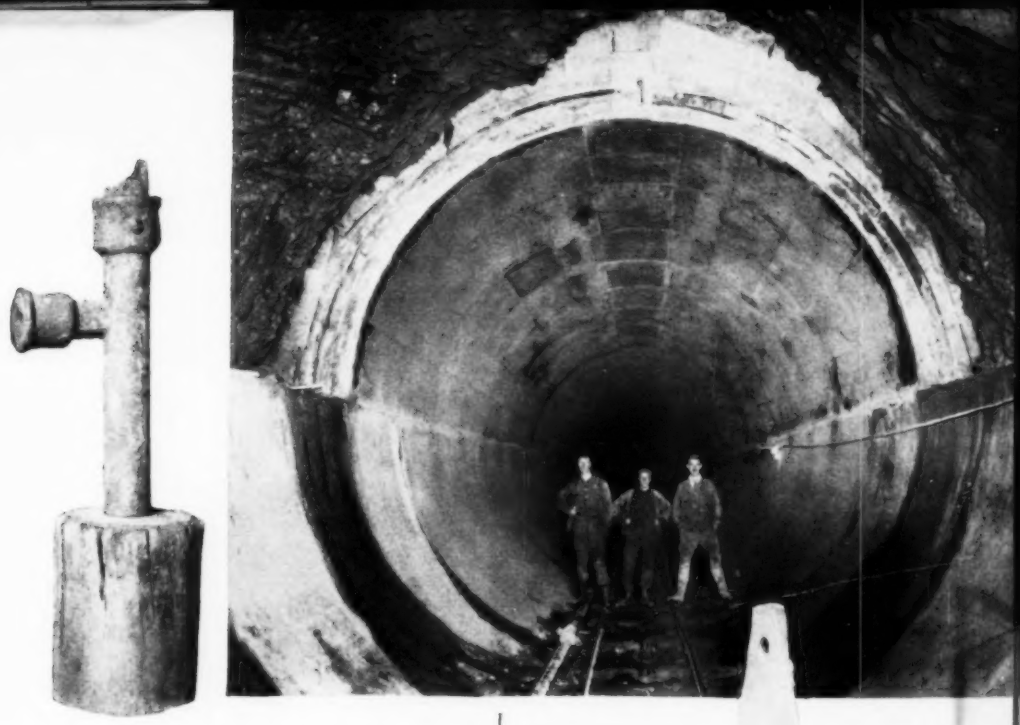
Before reaching the city, the water is stored in distribution reservoirs. Consumption is so heavy that at certain hours the mains would be drained dry if they got their supply direct from the aqueduct. The distribution reservoirs, however, have time to fill up again during the hours of slack consumption. It is distributed through the city in 4,726 miles of mains, the principal ones at depths of from 200 to 700 feet. That is to cushion the pressure, which is 400 pounds to the square inch at the 700-foot level. The normal water pressure in the mains will spout a jet to the height of a six-story building.

Engineers deal gently with water at such pressure. Not only do they bury the main pipes at least 150 feet, but the valves which shut off sections of the mains are built to operate with discretion. It takes 45 minutes to close a valve in a four-foot main and to close a 12-inch pipe 80 turns must be made of the valve stem. Such deliberation, while it might annoy a householder whose cellar was being flooded, insures such a gradual stoppage of the flow that no sudden pressure is likely to cause a new break.

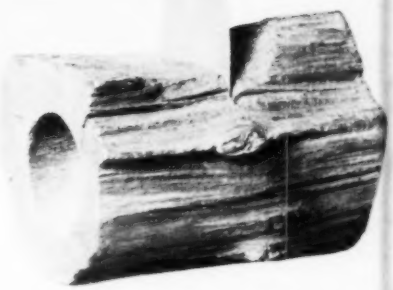
Leaks are expensive and often hard to trace, particularly if the water is escaping from one of the deeper pipes. The city keeps eight crews at work hunting them at a cost of $95,000 a year. The leak hunters use a device called an aquaphone which, when placed near a main, enables a listener to distinguish the sound of a leak's squirt or trickle from the rush of the main flow. A survey of the situation in 1934 had showed such waste reached the almost incredible total of 150,000,000 gallons a day so between 1934 and 1937 W.P.A. employees inspected 437,000 buildings and found 400,000 leaks, and a faucet which leaks drop by drop will waste 15,000 gallons in a year.

By concentrated effort, consumption was

An aeration plant. The water is sprayed into the air to remove gases which might cause bad taste or odor



The old and the new. Two wood pipes from New York City's early water system. The metal slide in the one at right served as a valve. Above, a modern concrete water-supply tunnel



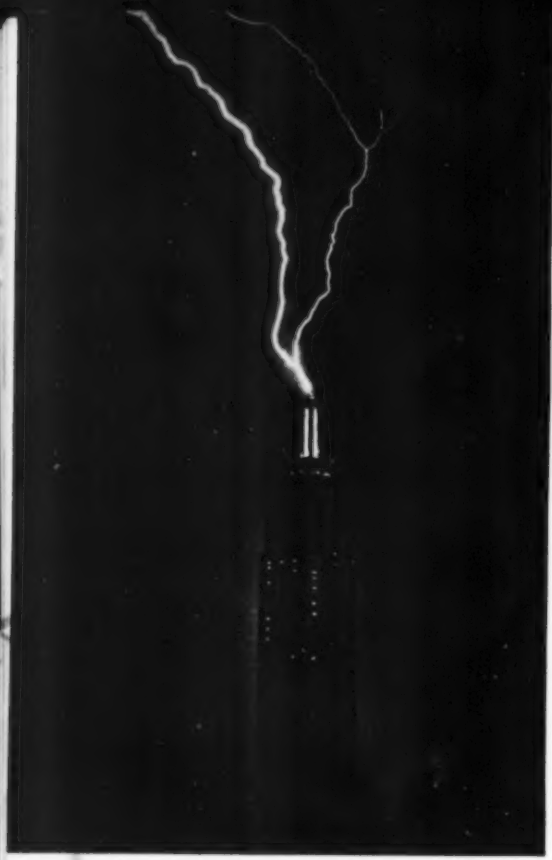
reduced by 75,000,000 gallons a day. It was another astounding development in New York's amazing water supply system, and one which has been studied since then by numerous cities.

There has been no interruption in the service of the Catskill aqueduct through breaks, but the city is prepared for that emergency. It keeps the Kensico Reservoir, which is close to the city, well filled at all times. It holds 30,000,000,000 gallons and could supply the city for two months with its stored water if the Catskill supply was shut off. The progress of the water from mountains to tap is stately and ordered in any event. It probably takes at least two months for any given gallon to go from Catskills to tap, and it may take a year.

By the time it reaches the city mains it isn't just water, either; it is a kind of Catskill cocktail, cleansed of smell and taste and harmful qualities. One thousand tons of chlorine, 100 tons of copper sulphate, 3,500 tons of alum and 700 tons of lime hydrate go into it in the course of a year and it is aerated by picturesque clusters of fountains at Ashokan and Kensico.

The chlorine, which has been used since 1907 when typhoid cases in New York were traced to an epidemic in Katonah in the Croton watershed, takes care of the germs. Since that time no case of typhoid has been traced to the city's water. The copper sulphate deals with tiny organisms which, according to their kinds, might give the water the smell of geraniums, fish, or cucumbers. The alum precipitates the silt with which the water becomes impregnated when rains sweep the steep slopes of the Catskills, transforming gully trickles into torrents. The lime hydrate counteracts the acid effect of the alum.

The water is constantly under scrutiny at three chemical laboratories. Twenty-nine thousand samples are analyzed each year and, according to the conditions found, prescriptions are issued for the mixing of the Catskill cocktail. The simple test of the palate is one of the most important ones.



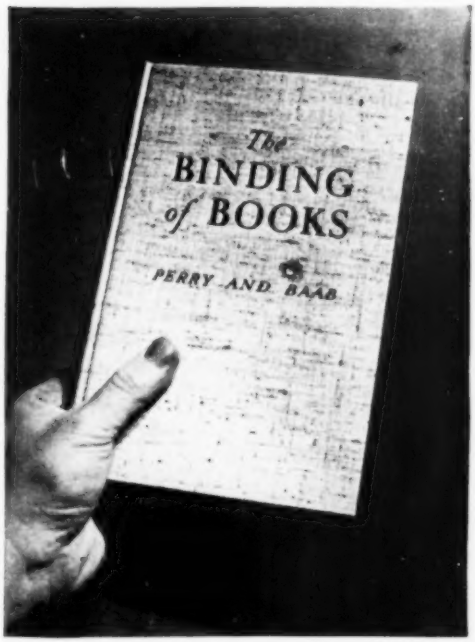
## New Book Tells Saga of the Golden Age of Electricity

ELECTRICITY is the hero of John Winthrop Hammond's "Men and Volts," (J. B. Lippincott, $2.50). Starting with the pioneer products of Thomas A. Edison, Charles F. Brush, Elihu Thomson, Charles P. Steinmetz and other giants of early research, the author tells the story of the birth of the electric light, the electric railway, the modern dynamo, wireless telegraphy, modern radio, and other wonders that came from research laboratories in the last decades of the Nineteenth Century. He tells how 10,000 persons gathered around the courthouse in the little town of Wabash, Ind., in 1880, on the night when current was turned on in this first community to be lighted solely by electricity. A central thread in the narrative is the influence, over a period of thirty years, of the General Electric Company and its research laboratory in Schenectady, N. Y. Steinmetz and his man-made lightning; E. F. W. Alexanderson and his history-making high-frequency alternator; Irving Langmuir and his gas-filled incandescent lamp that doubled the efficiency of previous lamps in a single stride, provide high points for the later portions of the book.

## Manual of Book-Binding Art Has Home-Workshop Tips

TIPS on binding and repairing books, by means of the tools and equipment found in an average home workshop, are contained in the 160 pages of "The Binding of Books" by Kenneth F. Perry and Clarence T. Baab (The Manual Arts Press, $2.). The book consists of two sections. In the first, the authors explain the general principles of book binding, tell when repair and rebinding are necessary, and make suggestions on the best materials to use and the tools and equipment that will be needed. The second part of the volume covers 31 processes used in book binding. Step-by-step instructions are provided and the tools and materials needed are indicated in each case. Thirty-five photographs and more than 70 drawings illustrate the book.

*If your bookseller cannot supply the book you want, send your order with remittance to Book Department,* POPULAR SCIENCE MONTHLY, *353 Fourth Avenue, New York City.*



# LATEST SUBMACHINE GUN
## IS DESIGNED FOR MASS PRODUCTION

"Answer to an ordnance officer's prayer": the Reising gun

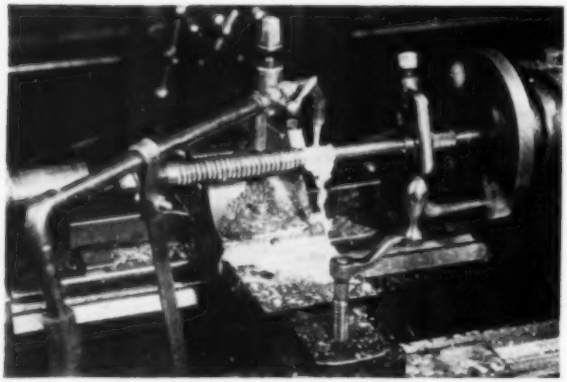
Boring the stock. The new weapon could be manufactured with the tools found in any well-equipped machine shop

A NEW submachine gun which shoots .45 caliber automatic pistol bullets at the rate of 500 a minute is now being turned out by the Harrington and Richardson Arms Company, of Worcester, Mass., at the rate of 1,000 guns a day.

Although in its present form the gun weighs only $6\frac{1}{2}$ pounds as compared with the $9\frac{3}{4}$-pound Thompson submachine gun and the U. S. Army's new $9\frac{1}{2}$-pound Garand rifle, the inventor, Eugene G. Reising, is confident that eventually he will cut its weight down close to the five pounds which the War Department considers ideal for parachute troops, air infantry, motorcycle riders, and the close-up work of mechanized units. He is also adapting it to fire the .30 caliber carbine cartridge.

Just as important as its light weight, however, is its simplicity. The Reising has only three moving parts—the hammer, bolt, and action bar—compared with eight in the widely used Thompson ("Tommy") gun. According to the Worcester experts, it is easier to make a complete Reising gun than it is to turn out any one of the three most complex parts of a comparable weapon. Because of the simplicity of its construction the tolerances of error allowable in the Reising are much wider, making it entirely practical to manufacture the gun in any machine shop without special tools. Actually a large part of the machine tools being used at the present time to produce the 1,000 Reisings a day are fifty years old.

Although special tools are not required, several are being used to speed production. Notably, the Reising barrels are being rifled by the broaching method. Heretofore gunmakers have rifled barrels by a process requiring the tool to make a number of trips through the barrel, cutting the rifling grooves slightly deeper each time. By



Here cooling fins are being cut on the 11-inch barrel, to keep it from overheating even when fired at the rate of 500 shots a minute

Cutting the rifling grooves. By the broaching method, this is done with only one trip of the tool through the barrel. With an automatic lathe, a solid bar can be turned into a barrel in 12 minutes

broaching, the 11-inch barrel of the Reising is rifled in one trip through, taking only one minute instead of the old method's 15 minutes. With the installation of an automatic lathe, only 12 minutes will be required to finish a barrel, from the solid steel bar to the final bluing.

Simple as it is, the Reising is capable of grouping a high percentage of its shots inside a ten-inch circle at 200 yards, and that, remember, is with standard .45 automatic pistol ammunition. One reason for this accuracy is the compensator, which is screwed onto the muzzle like a silencer. Slots on its top side permit the gases leaving the muzzle to expand upward, while a small shelflike projection on the under side of the compensator takes a downward push from the gases, and these two effects combine to keep the muzzle down and on the target, eliminating almost all the "jump" of the muzzle. The recoil, or kick, also is very slight.

The Reising can be fired either semiautomatically, one shot at a time, or automatically at full speed by holding down the trigger. No handheld weapon, of course, can be as accurate when fired automatically as when fired one shot at a time and sighted for each shot. Also, the shortness of the barrel prevents

A great advantage of the Reising gun is its simplicity. There are only three moving parts: the hammer, bolt, and action bar

In assembling the mechanism, the bolt is first inserted in the receiver, as below

The hammer comes next. In firing, the bolt remains locked, increasing the gun's accuracy

Now the action bar is put into place. This completes the assembling of the mechanism, which . . .

accuracy equal to a rifle's. Like most submachine guns, the Reising has an effective range of 300 yards.

The .45 caliber bullet leaves the muzzle at a velocity of 900 feet a second. Velocity and the bullet size both figure in the hitting force and penetrating power. Rifle and carbine bullets tend to drill a clean hole through a man, and he may continue to advance for some yards after being struck in certain parts of his body. The .45 caliber slug, on the other hand, will almost always knock a man down or spin him around—a valuable asset in close-up fighting where it is necessary to disable the other fellow before he can get you.

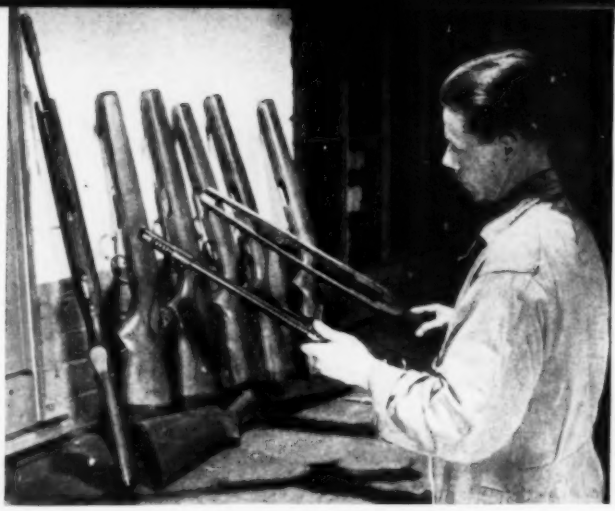
The Reising gun takes a 20-shot clip magazine, and a 50-round drum can be adapted to it if wanted. Thanks to its simplicity, it can be sold for around $85, or, in military mass production, for $45 to $50, which is a lot less than the $225 price of a comparable submachine gun now in wide use.

Like the Thompson, the Reising gun is of the delayed blow-back reloading type. A pressure of 42 pounds is required to force the bolt to cam itself out of a locked position. A shoulder half encircles the upper part of the bolt; this fits snugly up against a mating recess in the upper inside part of the receiver. These locking parts are milled at an angle to provide transfer of the reaction from one plane to another. The reaction pushes the fired cartridge shell back until it engages the ejector and is flipped out. The same movement cocks

. . . is ready to be fitted into the 13½-inch pistol-grip stock, made out of oil-finished American walnut

The Reising gun takes a clip of twenty .45 caliber cartridges of the type commonly used in automatic pistols

Eugene G. Reising, the inventor, examines his contribution to defense. He holds over 60 firearms patents



Assembling submachine guns at the Harrington and Richardson Arms Company plant in Worcester, Mass., where 1,000 are turned out in a day. Many of the tools being used are 50 years old

the hammer. A retracting spring pulls the bolt forward; on its way the bolt picks up a loaded cartridge from the clip and feeds it into the chamber and then fires it. The whole takes (at the rate of 500 a minute) about 3/25 of a second.

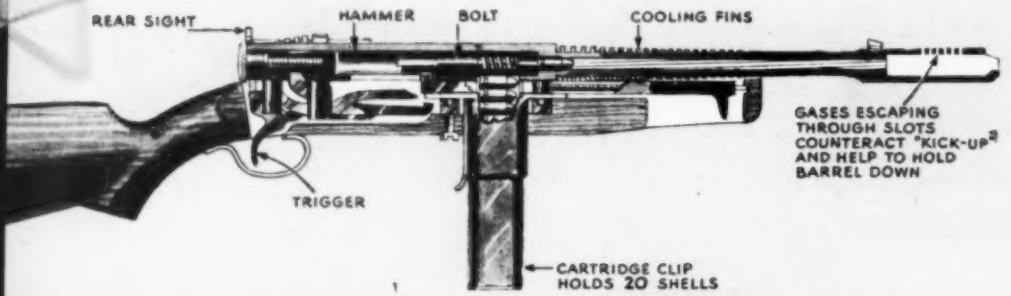
Despite its short barrel, the gun has a sighting radius of 18½ inches. The barrel, of nickel chrome steel, has cooling fins similar to those on the Thompson gun. After 100 rounds rapid fire it is not sizzling hot, and one of the first Reising guns made has been fired more than 9,500 times without any signs of charring the stock and also without overhauling.

The gun can be taken apart without even using a cartridge as a tool. Unlike other submachine guns, it does not have to be lubricated continuously, and Army tests at the Aberdeen, Md., proving grounds showed that it could even be fired dry of oil. In these tests, 3,470 rounds were fired with but two failures, one due to a defective cartridge and the other ascribed to incomplete locking of the breech.

The inventor, Reising (pronounced "Rise-ing") holds more than 60 patents on pistols and guns. Many experts consider his .22 caliber automatic pistol the best ever made in this country. Of Swedish stock that came to Delaware in 1635, Reising was born at Port Jervis, N. Y., son of a railroad engineer who died when Eugene was an infant. The boy attended Lehigh University three years, then punched cattle in Texas and Mexico a few years. On returning north, he went to work for Colt, testing and selling arms. He helped John Browning develop the famed Colt .45 automatic pistol.

Just before the first World War, Reising designed a simplified machine gun. Later he designed repeating and automatic rifles for Mossberg & Sons, Marlin, Savage, and Stevens. The keynote of nearly all his 30 designs is ease of manufacture.

Besides the U. S. Army, the war departments of Great Britain, Greece, the Netherlands East Indies, Iraq, and several South American countries have expressed keen interest in this apparent answer to an ordnance officer's prayer: a simple, very light, easily made arm, sturdy, dependable —that can be turned out in a shop without costly equipment.—WALTER HOLBROOK.



# Denver Students Learn MOVIE MAKING in the Classroom

By EDITH M. STERN

IN DENVER, high-school students produce sound pictures as part of their regular class work. Two hours every school day go to this new way of bringing social studies together under one teaching device.

Fun? Of course! Who wouldn't want to help produce a movie? Yet only a small proportion of the time is given to picture-making; most of it is taken up by background study, of the sort the kids would be having anyway though less intensively. Youngsters give Saturdays,

A high-school camera crew shoots a scene in the Denver General Hospital as part of a documentary-film script on public health written by students

holidays, early mornings, and late afternoons as cheerfully to field trips as to actual shooting.

It's hard work, too. I watched boys and girls tracking down the living stuff of economics, hygiene, and civics; found them in factories, banks, municipal bureaus. I saw them applying physical and chemical principles to the realities of photography and film development; saw them learning effective English through sound-track description that must make its point in a few seconds.

There's nothing amateurish about these pupil-made pictures. From the moment the projector began to click in the darkened basement of the Denver Public Schools Administration Building, I sat enthralled. Each picture dramatically makes its points on health protection, food production, or recreation.

"They *have* to be good," explained Dr. R. A. Hinderman, director of vocational education in Denver schools, "otherwise they would give the children no satisfaction. And they are the best means I know for teaching what it is to live in a democracy."

Democracy begins with informed group discussion, and so do these classes. All Denver's high school pupils know something about the city's industries and agencies, but the movie-making classes go into details. "You're going to produce a permanent record," say the teachers, who try to have their pupils think for themselves. "You'll have to become responsible experts on your subject. We'll help by suggesting background reading to make you intelligent interviewers. Then you must decide where you are going and whom you are going to see."

Everyone contributes suggestions. For the film assignment on health, students proposed the State Board of Health, the sewage-disposal plant, water works, hospitals; the library, for mental health is important; welfare agencies, because underprivileged more quickly spread disease.

One class attempted to explore the community 40 strong. It didn't work. So they discovered the advantages of representative government. They divided themselves into committees of three, each to search some part of the field and then inform the group through reports and snapshots.

Pupils of one high school made 100 contacts, from W. P. A. to Metropolitan Life Insurance Company; another group covered 1,000 miles. These expeditions involve more than looking; they uncover facts.

In the beginning the interviewers preferred the reassuring company of their teachers. Then they discovered that public servants really want to serve the public, the younger generation included. "Dr. Cullyford treated us as if we were high officials," a slender, sallow boy in a frayed brown sweater told me after a visit to the State Board of Health. A tenth-grade girl informed me that "Dr. Mitchell certainly wanted us to know what he was doing because he kept us in his laboratory for two hours!"

Businessmen also encouraged the inquiring producers. Bankers turned out to be regular fellows willing to explain financial statements and calculating machines. Executives in meat-packing plants walked with students between long rows of beeves to explain sanitary measures. A boy, who told me he'd been awfully scared at first, interviewed one of Denver's leading businessmen. "He was swell," he said. "After that, I felt I could go to see anybody!" One democratic fact of democratic life was noted early—the higher they are, the easier they are to talk to.

They exercised, too, their American prerogative of spotting what's wrong as well as what's right. "That commissioner didn't seem to know a thing about his job!" a plump little blonde in a corduroy jumper reported indignantly. "Everything we asked him, he said, 'Well, you'll have to ask someone else.' Things it was his business to know!"

The happy ending of a finished picture is kept in sight through the long suspense of fact-gathering by showings of such documentary films as "The Plow That Broke the Plains." Through group analyses, pupils learn techniques and what to aim for. How was music used for emotional effect? Which photographic details built up the desired impression?

An important step is to decide what message shall be carried to their audiences. Shall they interpret the assignment "Food the Modern Way" to concern itself with *more* food or *better* food? Denver pupils decided that sanitary manufacture was less obvious, and therefore more interesting, than quantities of foodstuffs pouring into the city's markets.

Then into a written scenario goes the story in terms of action and pictures. I've heard hot debates in Denver classrooms. Follow a woman carrying home food? Nonsense! Boring and needless, when glimpses of a well-stocked grocery perfectly convey the impression of assortment and attractive packaging. Microscopic slides enlarged on the screen? Too much detail; the laboratory is enough. General view of a flour mill? No! Rather a close-up of a grinder in action.

Pupils with enough motion picture procedure and terminology to work intelligently break down the scenarios into shooting scripts, complete to the last minutia of tim-

ing and scene footage. After that, boys and girls revisit scenes in the shooting script.

Zero hour. Filming starts. The street-cleaning department obligingly deposits a dead dog in the street so one of its trucks can pick it up. A farmer in the midst of spring plowing maneuvers his tractor for the sake of the perfect shot. A baker spruces up and shaves on request. A milk inspector stops the same milk wagon over and over again before the students' camera.

All pictures—good, bad, and indifferent—are spliced together in the order called for in the scenario. Teachers who know how to suggest without dictating help pupils edit the "rush." "That picture of me drinking buttermilk ought to come out," a girl pretty enough to rate Hollywood said decisively. "We're trying to show how cartons keep milk sanitary, and a person drinking doesn't add a thing." "I hate to see the dancing scenes taken at my house cut out" another girl remarked. "But they do slow the action."

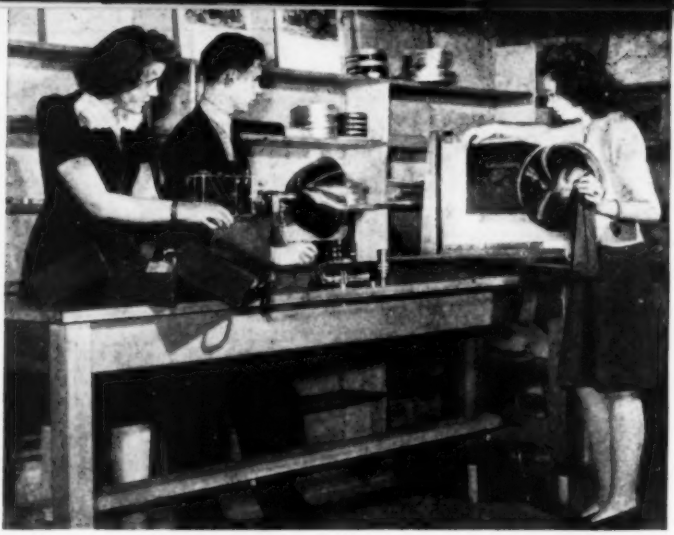
Meanwhile, some students design titles, some arrange the incidental music. Others work on narrative and captions. A brief phrase like "We put the icebox on wheels," to describe a refrigerated train, is adopted after numerous wordier predecessors.

At long last the pictures are ready for their première. An audience of school children, teachers, parents, and friends is stirred to fresh appreciation of citizenship when they see "How Our Health Is Protected"; technologists in the State Laboratory peer into their test tubes, white-wings wield their brooms, water spurts from the pipes of the municipal aërator, visiting nurses go their rounds. "It's Fun to Play" pictures the wide variety of inexpensive

Gathering data for a movie on foods, a student committee interviews the manager and superintendent of a Denver candy factory

To show how their city gets its water, young movie makers photograph the Marston Lake reservoir and, at right, the water works

Technical information on movie making is provided by books in the school library



Photographing a title in the basement of the Denver Public Schools Administration Building. Students do the art work

recreation available to boys and girls. "Food the Modern Way" makes you hungry. Flashes of a gorgeous rooster, a massive hog; machines vacuum-packing, mixing, grinding, wrapping, and packaging; in the end, salads and roasts and chickens, delectably displayed.

Three pictures have been finished since Denver inaugurated the activity two years ago. "How to Find a Job" is still in production stage, but even an uncompleted pupil-made documentary has its educational value. Positions were found almost immediately upon graduation by 17 of the 20 boys who worked last year on the job picture, as against not one in the graduating class the year before.

A banking film, approaching completion, was undertaken at the request of Denver bankers who found how little the youngsters had been learning on tours through the banks. The visitors had been more intrigued by a vault door than by the Odyssey of a check. Only when faced with the necessity for picturing someone writing a check, where it clears, and how it is spent, did they think through complicated financial transactions. You can't comprehend a mortgage by visits to a teller's cage or a vice president's sanctum; only by way of pictures the masons, carpenters, and plumbers employed through housing loans become real.

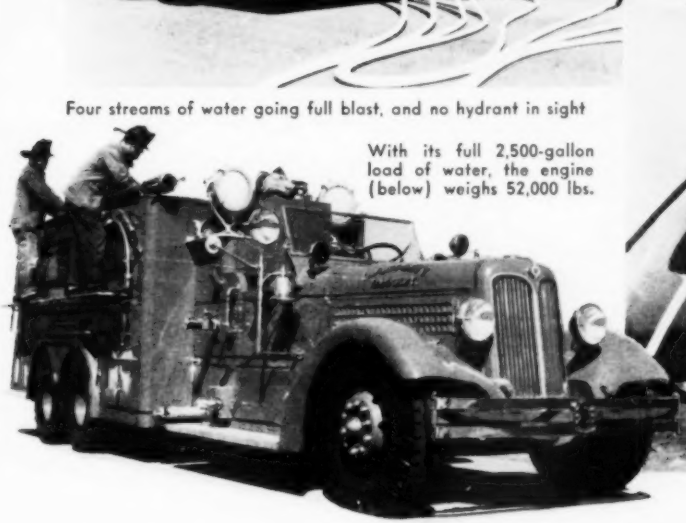
"I'm all for this new teaching method," James K. Sanbourne of the American Institute of Banking told me. "The children's scenarios showed *(Continued on page 228)*

All the film shot on a subject is spliced together and then edited, as shown below

Viewing "rushes" of completed film. Helped by a teacher, pupils suggest revisions and retakes before final release

Four streams of water going full blast, and no hydrant in sight

With its full 2,500-gallon load of water, the engine (below) weighs 52,000 lbs.



Special nozzle combines a straight stream with spray for close-up fire fighting

## Fire Engine Carries Its Own Water Supply of 2,500 Gallons

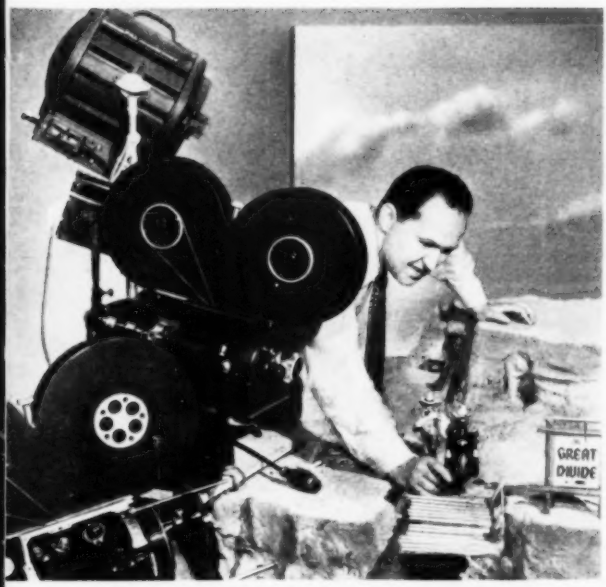
FOR FIGHTING FIRES where no water is available, Downey, Calif., has a 52,000-pound fire engine that carries its own water supply in a 2,500-gallon tank. It is also fitted with a suction hose for use near hydrants or ponds, and can pump 900 gallons of water a minute. To get the most effective use of its water supply, the truck has 1½-inch diameter hoses, fitted with nozzles that combine a fine spray with a solid stream of water smothering a fire in a blanket of fog.

## X-Ray Film Worn on Wrist Detects Peril to Workers

PROTECTION against the possibly harmful effects of overexposure to X rays is provided for workers in the General Electric X-ray laboratories by "safety wrist watches." They are leather cases containing pieces of unexposed X-ray film. If a worker encounters stray X rays, black spots will appear when the film is developed.

*Jim Dandy, latest Hollywood heart throb. The new puppet technique casts him in "puppetoon" full-color movie rôles*

# Puppet Movies




George Pal sets up characters on a movie set. They are puppets—with no strings attached. Action is obtained . . .

ACHIEVING a third-dimensional effect by combining puppets with actual sets. George Pal, 32-year-old Hungarian, has brought to America a new form of movie presentation. First of his color cartoons reached the screen recently as a nine-minute show.

Instead of drawings, Pal uses wooden characters which perform on tiny sets, with synchronized music, songs, and special effects. Although the actors are puppets, there are no strings; for no Pal puppet ever moves. Instead, the artist places on the set a complete stationary figure for each phase of a movement. When the heroine makes eyes at the hero, 28 individual heads are fitted, one after another, onto her body, the first showing her eyes wide open, the last with them closed.

First step in preparing a "puppetoon," the word being derived from puppet and cartoon, is the writing of the script, followed by composition of the music in order that movements of the characters may be properly timed, and designing of the sets. Pal then makes color

. . . by changing their position or features between shots. A realistic third-dimensional effect results, as shown below

drawings of the first, middle, and last phases of each movement, while assistants complete 25 or more intermediate drawings.

From these rough cartoons, the puppets are built. Finally, they take their places on the tiny sets, which may be a miniature railroad, or a model of a mountainous mesa against a painted cloud background. Frame by frame, each puppet takes a new position, or his head and hands are changed.

Pal was a successful cartoonist in Berlin seven years ago, and in 1935 formed his own studio to experiment with the puppet-cartoon idea. Later he produced similar pictures in Holland. Trained to be an architect, he is applying at his Hollywood studio principles learned in that profession.

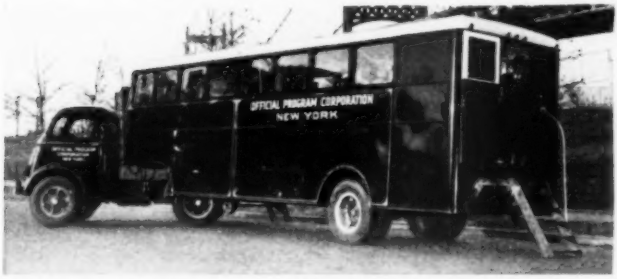
Prunella, Pal's heroine, has 28 separate heads with expressions ranging all the way from smile to frown

Jim Dandy, also many-headed, here inspires his creator in the planning of a script in which he is hero

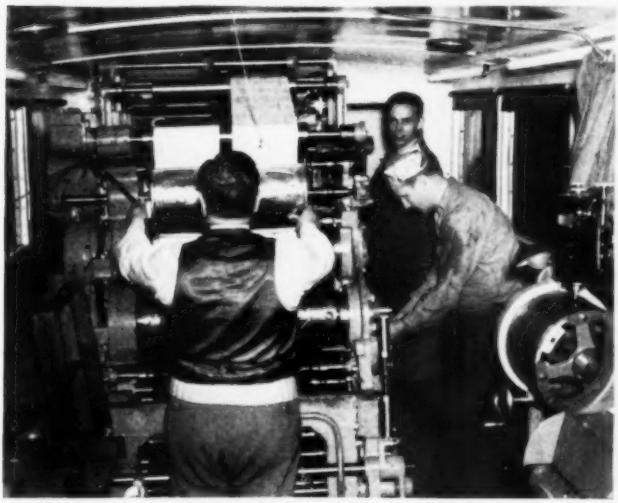
Hand Car Joe, another star, hasn't the hands his hand car has, but he burns up the tracks in a pinch

In the prop shop, sets and properties are prepared in miniature with the same care the characters get

## Print Shop on Wheels Runs Off Race Programs at Track




Mobile program factory weighs 35,000 pounds, including a 4½-ton press



All its printing machinery is crowded into a space of 31 by nine feet

THERE are more ways than one to lose money at a race track, and one of them is printing too many programs—or too few. If too many are printed the left-overs are wasted; if too few, betting falls off and the track loses money. So when Barnwell Ellicott, head of the Official Program Corporation, approached New York track managers with a plan for a mobile printing press that could turn out programs at the rate of 10,000 an hour just before the gates opened, the managers jumped at the chance. Staffed by six men, the print shop on wheels houses linotype machines, stereotyping equipment, a rotary press, and a binder, all in a floor space of nine by 31 feet. In winter, when northern tracks close, the 35,000-pound print-shop goes south, thus permitting all-year-round operation. Printing starts about 9:30 a.m. with the management watching the weather.

## Steel Goggles Protect Eyes From Bomb Splinters

PROTECTING the eyes from splinters and other flying objects during an air raid is the purpose of new-type goggles introduced in Britain. Made of sheet steel, the goggles are held in place by a strap. Holes approximately an inch in diameter cut in the metal permit good vision with moderate protection. In emergencies, circular plates of metal swing down over the eye holes. Cross slits cut in the plates then allow restricted vision, but with maximum protection to the eyes. Rubber padding under the cutout bridge and across the brows permits the goggles to be worn in comfort for a long time if necessary.

## Washable Sport Shoes Leave Soles Behind as They Go to Laundry

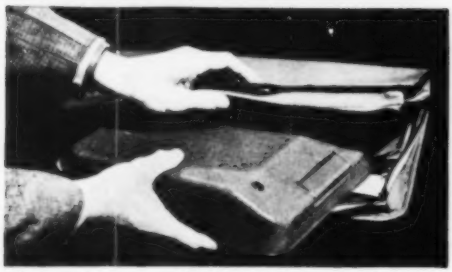
Upper, attached to sole by invisible fasteners, snaps off, and is therefore more likely to fit again after laundering

WASHABLE sports shoes have been introduced as a practical innovation for women. Invisible fasteners attach the upper, of kid, to the sole, as shown in the illustration at upper left. Whenever the upper needs laundering, it may be detached, as in the view at upper right. Washed like a glove, it is then hung up to dry, and subsequently snapped back on the sole again with less danger of producing a bad fit.

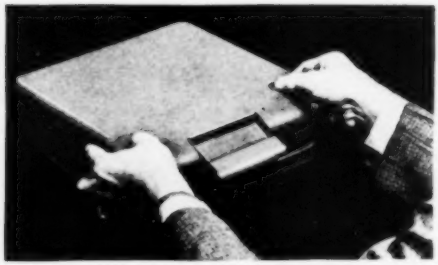
## Typewriter, 11 Inches Square, Fits into Brief Case

CALLED the smallest of its kind, a portable typewriter of Swiss design fits with ease into a brief case. Although it measures less than two and a half inches high, and eleven inches square, the typewriter has many of the features of standard models. Its weight is eight pounds and 11 ounces, with cover. It may be carried conveniently by a telescoping handle built into its cover. For various languages and professions, 240 different keyboards are available.

Compact typewriter (left) is available in 240 different kinds of 4-bank keyboards



Covered, it can easily be slipped into a brief case

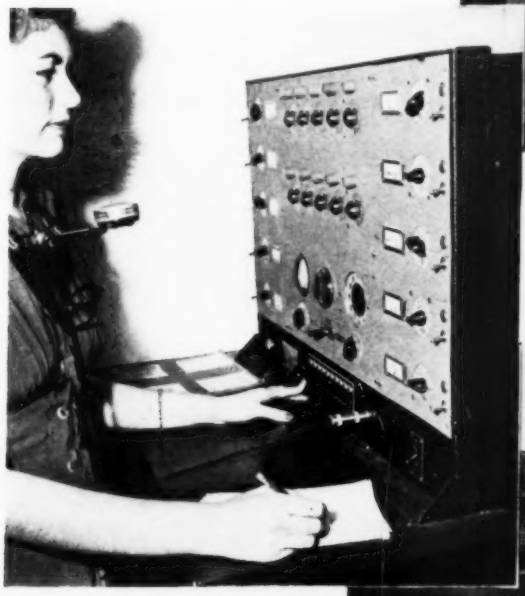


Pressure on two buttons enables cover to be removed

# Nickel Buys a Tune and a Phone Chat with a Girl as Well

COIN PHONOGRAPHS, or "juke boxes," widely used in taverns and restaurants, now are sometimes installed in a new form. Operated by telephone from central offices, they permit a selection of 300 or more tunes, as opposed to the 12 or 20 available on ordinary coin phonographs. Girl operators, chosen for their pleasing voices and ready wit, make wisecracks and occasionally sing with the records. When the customer places a nickel in the slot, a light flashes on the operator's board at the central office. The customer, speaking through a microphone, then gives the number of the record he desires played, and the operator selects the disk from a rack and slips it on a phonograph turntable. Each operator cares for ten turntables, representing as many different "juke boxes." By putting additional coins in the slot, a customer can have his selected tune dedicated to anyone in the room or in some other place with a similar machine.

Above, a customer puts his nickel into the slot, selects a tune from the list overhead, and talks into microphone to girl operator



Left, operator sees light flash and presses button to make voice contact. If the tune is to be dedicated, she puts down the name

Right, operator takes disk from rack and puts it on turntable as she keeps up a line of chatter

A student parachutist riding the wind after a free jump from the Marine Corps training tower at Hightstown, N.J.

# School for Sky Soldiers

*A Parachute Trooper Has To Be Ready for Anything, and Here's How He Gets That Way*

By WALTER HOLBROOK

THE parachute troops of the Army and Marine Corps are tough outfits. Only outstanding men with at least a year's experience in uniform are picked and they are toughened scientifically. They are hard-boiled "canopy" jugglers by the time they are assigned to a parachute battalion.

Ground and lofty tumbling is their meat from the moment they are accepted for the service, for which the number of volunteers far exceeds the rate of acceptance. They must be muscular and intelligent and gifted with initiative, and nobody weighing more than 185 pounds is accepted. By the time they are ready for service any one of them probably could throw over his shoulder the Siamese tumbler who made the first recorded parachute jump from a pagoda in 1687.

Starting with drops of six or eight feet to get used to the jolt of landing, they progress by way of the tower-guided parachute to jumps from planes, and all the time they are being hardened for wrestling matches with recalcitrant, gust-driven 'chutes and for the exacting field service for which a 'chute jump is merely the preliminary. They must be capable of a good many miles a day afoot, running a good portion of it. A 'chute soldier seldom is seen walking while on duty; he executes all orders at double time.

The parachute troops have gone back to the old static-line 'chute, which has a strong cord attached to the plane, because of the

# TRAINING

1 Recruits for the U.S. Army's parachute battalion, in training at Fort Benning, Ga., are hoisted in harness and dropped to accustom them to the bump

2 With this apparatus, which imitates the sideways drift of a landing 'chute, they learn to yank the suspension lines to lessen the shock

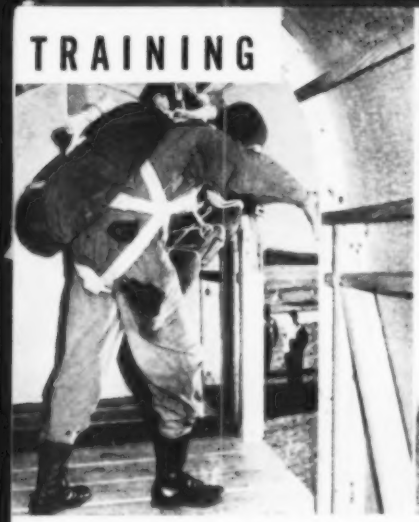
3 Jumping from this platform gives them the habit of landing relaxed, bending the knees, and spinning around to hit on the soft part of the body

4 With a buddy imitating the drag of a parachute blowing along the ground, a recruit practices getting on his feet quickly from any position

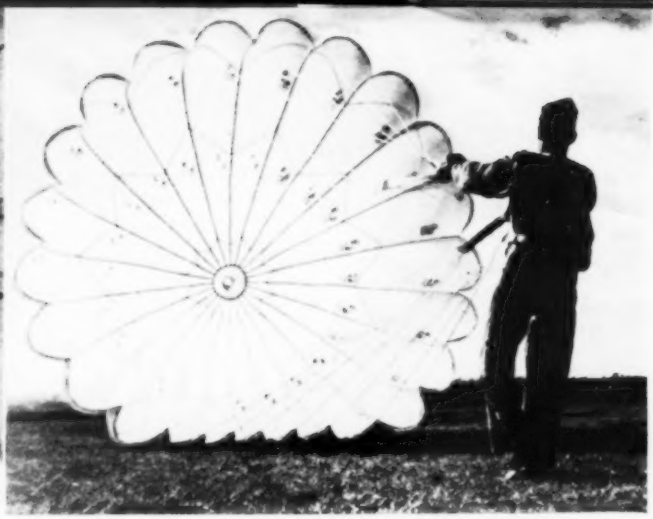
5 Tumbling is an important part of the training. It loosens and strengthens muscles, and teaches the men to take any kind of a fall without an injury

6 Stepping out of a transport-plane door in midair is an art in itself. At Fort Benning, they practice it with a mock-up of a plane fuselage

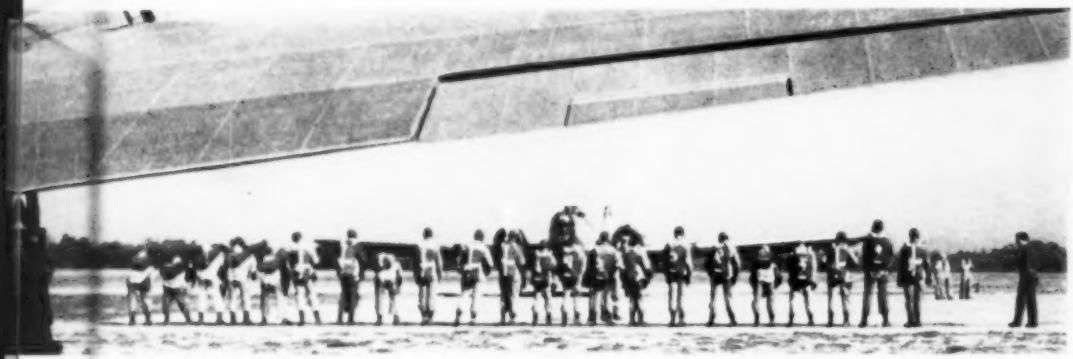
# TRAINING



The next step is to jump from the dummy with full service equipment



Before he ever makes a real leap, our sky soldier must learn to handle his 'chute on the ground when a strong wind is blowing



Now come "orientation" flights, in which the men get the "feel" of flying and study up on map reading

How a rip-cord parachute opens. In static-line 'chutes regularly used by sky soldiers, the rip cord is replaced by a line attached to the plane body

Pilot 'chute is fastened to center of main 'chute

SPRING RIBS OPEN PILOT CHUTE AND FORCE IT OUT OF PACK
PULL RING
RIP CORD
MAIN CHUTE
COVER FLAP
SHROUDS OR LINES FOLDED BACK AND FORTH AND HELD BY LOOPS
HARNESS

Ground practice with a cargo 'chute, used for dropping arms and equipment too heavy for men to carry

special conditions of their work. A static-line 'chute permits drops as low as 100 feet above the ground, and in war that means less time for enemy "parashots," or sporting old gentlemen with shotguns, to pot the parachutist.

Our Army and Marines are not planning to put the troopers through any 100-foot jumps in training or maneuvers, but it is to prepare for low jumps, as well as leaps in choppy air and high winds, that they are taught tumbling. All their exercise is directed toward strengthening their shoulders, arms, and leg muscles, and to make it second nature for them to land relaxed, on their toes, sink onto their knees, and twist quickly so that they will hit on the soft part of the body.

In normal air a parachute drops at about the same rate of speed as a skyscraper elevator, though unlike the elevator it does not slow up before stopping. If the air is choppy it may fall nearly twice as fast as normally. Normal is 16 to 18 feet a second, with the life-saving 'chute, which has a spread of 24 feet. The parachute troops, however, use 28-foot 'chutes, which let a 180-pound man down at the rate of 12 feet a second. This permits a man to carry more equipment than does a flyer bailing out of a disabled plane.

Under war conditions, when there may be no choice of weather or terrain, they'll need slow parachutes. Even in a moderate wind, a parachutist often lands going faster sideways than he is falling, which is pretty tough if he tumbles on rocks or concrete. A story current among U. S. Army parachutists is that the Germans lost 47 percent of their air troops at Narvik, by dropping them too low and on sharp rocks.

The German parachute trooper cannot maneuver his 'chute, for all the suspension lines come in at one point and he hangs below that like a monkey on a string, unable to reach them. The 24 lines on the American life-saving 'chute and the 28 on the trooper's larger 'chute are gathered at four points of suspension on the harness, two on each shoulder. By grabbing the six or seven lines

## PACKING

1 Men of the 501st Parachute Battalion at Fort Benning study a diagram showing how to fold a parachute, before tackling the job itself

2 Stretched out on a table, the 'chute looks like a big petticoat. Suspension lines are lifted and the panels inspected for burns, tears, and other flaws

5 Then the huge canopy is folded accordionwise to fit into the pack. Each sky soldier must learn to keep his own parachute always in good order

6 Suspension lines go into the pack first. Carefully folded, they are held in place by rubber bands to prevent fouling as the parachute pulls them out

which come in at one point, and pulling them down a yard or so, the 'chutist can slip or "fall off" in that direction, and thus avoid falling into a tree or water hazard.

Men accepted for training as parachute troopers must have "demonstrated soldierly qualities, agility, athletic ability, intelligence, initiative, determination, and daring," and be able to learn map reading, sketching, radio, and demolition. They must be expert with their weapons, unmarried, and not more than 32 years of age. They are turned down if heart action or blood pressure is even slightly off normal, or if they are subject to airsickness. The men receive additional pay, which is 50 percent more than what their regular ratings draw.

On arriving at the training station, Pete, as we will call our typical parachutist, is issued, in addition to his regular uniform, a suit of khaki coveralls, with a belted back and pleated shoulders, to afford maximum freedom of movement. At the wrists and ankles are adjustable bands, with buttons so they can be fastened snugly. His 14-inch, laced leather boots have an ankle brace built in, to be tightened before he jumps. Everything a parachutist carries in his pockets must be well fastened in: a jump amounts to about the same thing as being picked up by the heels and shaken, none too gently.

Pete's first lesson is in nomenclature. He

**3** With a man's life hanging in the balance, it is important to get each panel in its proper place so that the parachute will open without snagging

**4** With all the panels in place, the suspension lines are checked. If they are out of position, the canopy may foul, with fatal consequences

**7** The folded canopy now goes into the pack on top of the suspension lines. Greatest care must be taken to avoid disturbing the arrangement of the lines

**8** Finally, the completed pack is laced up and the end of the lacing line is made fast to the rip cord, or to the static line as the case may be

learns that the big silk umbrella itself is called the canopy, and that although it weighs only 1.35 ounces to the square yard, it has a tensile strength of 40 pounds to the inch, and a minimum tear strength of 4½ pounds. A 24-foot canopy is made up of 96 pieces of silk twill, sewn with four needles. A 28-foot 'chute contains 112 pieces. Four pieces, or panels, are sewn to form a gore, a narrow, pie-cut piece which is a yard wide at the edge of the canopy, and tapers down to less than two inches at the center. There is an 18-inch hole in the center of the canopy, called the vent, with a rubber garter sewn inside its edge so that as the 'chute starts to open the hole is only four inches across. Air pressure usually expands the vent to its full 18-inch diameter, and air escaping through this hole, of course, allows the 'chute to fall. But in strong updrafts, a parachutist may actually go upward, until he spills wind.

Above the vent is a 36-inch pilot 'chute. A steel spring makes it open first, at least in theory, and it helps pull the big 'chute open.

Leading from the vent, down through tape between the gores, then out in the clear for 16 feet more, to four points on the shoulder harness, are the suspension lines. These are of silk, too.

After the lesson in nomenclature, Pete

takes the first of a number of lessons in inspecting and packing a 'chute. Every parachute trooper must inspect, air out, and pack his own 'chute every 30 days.

Most of the 412 men of the Army's first unit, the 501st Parachute Battalion, spent six weeks learning to pack their 'chutes, practicing ground tumbling, and jumping off low platforms to get the hang of landing. The first real jump, however, was from a plane. Now, with the building of steel training towers—similar to the parachute jump at the New York World's Fair—the men will begin jumping from the tower as soon as they learn how to land. The pioneer Marine 'chutists have been using a tower at Hightstown, N. J.

AT FIRST, wires guide the 'chute straight down, although the trooper wears regulation harness instead of sitting in a swing seat checked by springs, as visitors did in the World's Fair jump. After two or three "captive" jumps, Pete starts making "fly-away" jumps from the tower.

The novice is now taught to grab the risers, webbing attached directly to the suspension lines, and twist his body so he'll face down wind. Otherwise, in landing, the 'chute is likely to pull him over backward. He is also taught to pull up on the risers just before landing to cushion his fall. The jar is equal to a jump from a $4\frac{1}{2}$ to six-foot fence.

Before he ever jumps from a plane he must also learn how to collapse his 'chute after landing, by grabbing one or more suspension lines and pulling it in fast until he can catch hold of the canopy. He then sits down on as much of the canopy as he can grab, and keeps on pulling it in. Even in a 14-mile wind, which is just a breeze, a fully inflated parachute will pull a man off his feet and drag him.

In the Army, the initial jump from a plane is made with the static-line 'chute, although the parachutist is taught to use the rip-cord type as well. In all practice jumps Pete will wear two packs, the reserve one being of the rip-cord type. He makes his first jump at an altitude of at least 1,500 feet in relatively still air. Before stepping off into the blue, he and his buddies fasten static lines attached to their 'chutes to a wire running along the side of the plane, above their heads. His weight jerks the 'chute open, and the line breaks away.

Later he has to jump in a 35-mile wind, and land in water, in a tree, and on top of a building. Before landing in a high wind or in the water, he must unsnap the harness around his legs and on his chest, then fold his arms, to hold everything in place. As his feet touch land or water he throws his arms above his head, and the 'chute is blown free of him. He is taught to sideslip away from trees or buildings, if possible. When landing in a tree is unavoidable, he must keep his legs tight together and kick away from the tree, so that only the canopy will get tangled in the branches.

The equipment of a parachute battalion, made up of 34 officers and 412 enlisted men, includes 386 pistols, 335 short-barreled automatic rifles, or carbines; 30 sub-machine guns, 27 .30-caliber machine guns, nine .60 caliber mortars, 30 folding bicycles, six automobiles, three motor cycles with side cars, two half-ton trucks, and five $1\frac{1}{2}$-ton trucks.

Obviously a trooper cannot carry a .60 caliber mortar down with him. In actual service he probably won't even carry a carbine, though the Army is experimenting with the idea. A pistol, perhaps two or three hand grenades, and a light silk rope for letting himself down from a roof or tree may be all Pete, the parachutist, will ever take down with him.

Cargo 'chutes will float carbines, machine guns, mortars, and folding bicycles to the ground. So troops will know which 'chute is which, the Army is experimenting with red, blue, and yellow cargo canopies. The Army is also experimenting with sky-blue 'chutes and smoke bombs to screen parachutists.

Since it is essential that the parachutist land as close to his equipment as possible, and also that, in many instances, a number of men land fairly close together, the Army flies transport planes as slow as possible while the men are going over the side. The pilot lets down the landing gear and uses the landing flaps to slow up. Some flights are even made with the plane doors off, to break the streamlining.

Once the parachute soldier has landed and picked up his equipment, he takes cover and fights like any other infantryman. So during the three months it takes to train a regular infantryman as a parachutist, he continues to practice digging in and taking cover, as well as target shooting.

BENJAMIN FRANKLIN was the first to propose the use of parachute troops, in 1784. The Russians got their idea for air infantrymen from experiments first conducted by the U. S. Army nearly 20 years ago.

The U. S. Army organized its first parachute company only last summer after the Nazi invasion of the Low Countries. The air infantry's work has progressed so well that the force is being expanded to include between 4,000 and 6,000 men. The Marines also are expanding their parachute forces, first organized last fall.

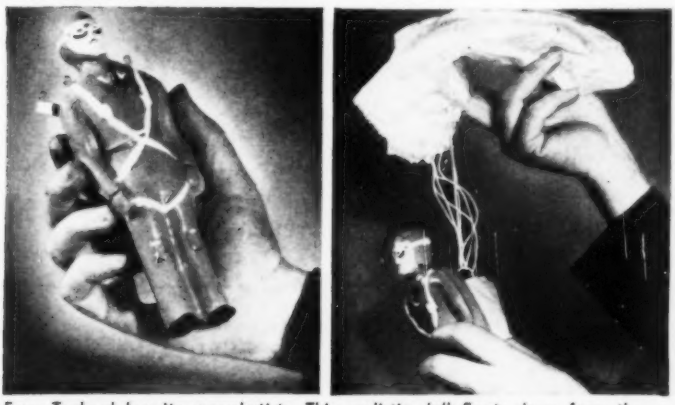
# MANUFACTURING

Sections of silk being sewed together to form a big "canopy"

A worker at the Pioneer Parachute Co. plant, Manchester, Conn., fastening the lines onto a pilot 'chute

PARACHUTE factories, of which there are five in the United States, are humming to fill Government orders for 40,000 'chutes to be delivered by June 30 for Uncle Sam's sky soldiers and our rapidly expanding aviation personnel. Despite a speed-up of about 500 percent, each 'chute is inspected six times during manufacture, again before acceptance by the Army or Navy, and finally drop-tested with a dummy from a plane. Both Chinese and Japanese silk is used, with Nylon as a possible substitute.

# PARACHUTE TOY



Even Toyland has its parachutists. This realistic doll floats down from the sky after having been hurled into the air with a slingshot, as at right

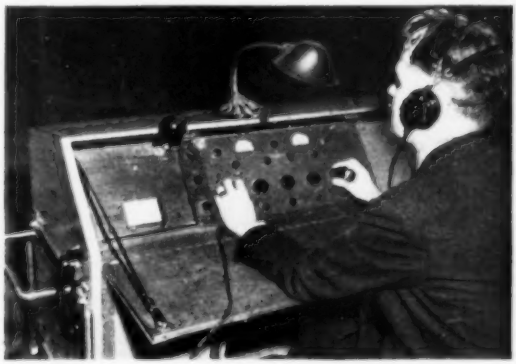
HURLED into the air with a slingshot, a toy parachute jumper invented by Frank Hammond, of Boonton, N. J., drifts back to earth under a tiny 'chute that opens from a khaki container on his back. An automatic vacuum timer opens the parachute when the jumper is 100 or 150 feet above the ground.

# SLANG RULES THE MOVIES

*"Kill the Baby!" the Cameraman Shouts. Not Infanticide—He Wants a Juicer (Electrician) To Turn Out a Small Spotlight. Studio Folk Speak a Language All Their Own. Here Are Some Samples Overheard During the Filming of "Las Vegas Nights"*

A *"Silk on the Broad"* is not a detail of costume. It means, rather, placing a silk cloth in front of a broad light standard, as below, to spread light

*"Barn Doors on the Bear Trap"* describes this method of hanging a portable light on the wall with two blackened wings to kill illumination at the sides



*"Tea Wagon's Ready"* reports Ed Hayman, the mixer. By which he means that he has his wheeled sound-mixing panel ready for its job of blending sound coming from several microphones

*"Shoot the Slate"* commands a director, and the cameraman photographs a board with marks identifying the scene just filmed

"Juicer Connects the Spider"

In other words, an electrician plugs cables into a "spider," or four-sided outlet box, to feed electricity to all parts of a set

"Tape Constance Cummings"

is not a prescription for a sprained ankle. A measuring tape is unreeled from the front of the camera to get exact focusing distance

When the cameraman calls for a "Duck" you don't give him the bird. What he wants is a canvas covering to protect his camera from movie rain. Excelsior deadens the sound

"Bert Wheeler Wants a Blonde"

and immediately there rolls up to the comedian a mobile dressing table with yellow lights that show how make-up will register

A drum of metal powder. In a new process, pressure and heat transform such powders into . . .

. . . metal parts like these. Unlike regular castings, these do not have to be machined

# COLD CASTING...

## a revolutionary process for making metal parts from powders

By JOHN WATSON

IN A toy department this last Christmas season, you may have seen a glistening metal airplane swerving and swooping after a wand waved by a demonstrator. If you did, you were gazing at a toyland application of one of the results of a new and booming development in the ages-old craft of working in metals. Powder metallurgy is its name. For the wand was an alnico magnet which is made by compressing aluminum, nickel, cobalt, iron and sometimes copper powders under tremendous pressure and then subjecting the compact, or briquette, to heat below melting point to complete the adhesion. Similarly, if you marvel at the nearly noiseless operation of your automobile engine, or if you admire the toughness of cemented carbide cutting tools, or the hardness of the new types of diamond-impregnated grinding wheels or diamond-drill core bits—all these advances are intimately related to powder metallurgy.

Powder metallurgy is a lusty and growing competitor of products made by casting and machining, die casting, casting-on, and other conventional methods. It is so new that no one knows where it is going, or how far—and yet, paradoxically, it is very old. The Incas in Ecuador cemented grains of platinum with an alloy of gold and silver, which drew the platinum particles together by surface tension to form a strong lump for further working. Thus they were able to work in platinum, which to them was infusible. H. A. Wollaston in England in 1828 described a method of grinding platinum to powder, compressing it in a mold, and heating it. Sir Henry Bessemer became so enraged as a young man at the high cost of "gold powder" that he developed a method of making a bronze powder which was the basis of his fortune. For 40 years Sir Henry and three brothers-in-law kept their process a secret, working in a factory without windows. Many of the men engaged in the craft today do not bubble over with information to a lay inquirer, but the in-

Photographs by SCHAAL

dustry has begun to open up as more of its applications and implications become known.

In general, powder metallurgy consists in mixing various metal powders—or combining them with nonmetal powders—pouring the mixture into a die, and subjecting it to a pressure which varies according to the type of product desired. The pressure may be as little as a thousand pounds to the square inch or as much as 140,000 pounds.

Precisely what goes on under the pressure is a mystery and the subject of a number of intriguing theories, such as cold melding, adhesion caused by friction, atomic fusion. But the point is that the stuff which went into the die a powder comes out a solidly compacted shape. It is then sintered, which means that it is baked in a heat below melting point but high enough to complete or supplement the adhesion. There are several variations of this general process.

For a new process to succeed, it must have demonstrable advantages over the methods with which it seeks to compete. Eric C. Gordon, president of Powder Metallurgy, Inc., who came into the powder-metallurgy field through happenstance, remained in it through interest, and has become an authority on the subject, lists a number of advantages which may be grouped under nine general headings:

1. The products desired are pressed to tolerance, that is to the shape and size desired, and thus expensive machining afterwards is eliminated.

2. Metals of exceptionally high melting point, such as tantalum, tungsten, molybdenum, columbium, and platinum can be processed by powder metallurgy.

3. Controlled and uniform porosity can be obtained in such parts as self-lubricating bearings and other pieces where porosity is desired.

4. Metals and nonmetals, such as copper and graphite, can be combined in intimate contact.

5. Eccentric shapes which are difficult and costly to machine, particularly in small parts, can be made with ease by powder metallurgy.

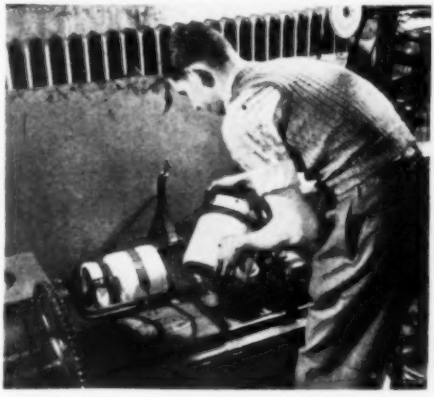
6. Different metals may be uniformly bonded into parts with unusual mechanical, chemical, electrical, or magnetic properties.

7. Materials widely different in specific gravity can be combined without segregation.

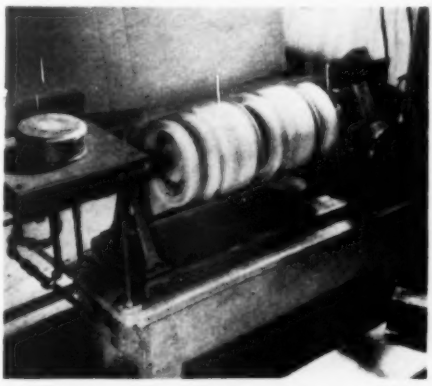
8. Density may be varied where weight is a factor.

9. Time is saved in the manufacture of small pieces. Several hundred thousand pieces may be produced rapidly, or the

Metal powders, sometimes mixed with nonmetallic materials, are weighed and placed in a jar mill . . .



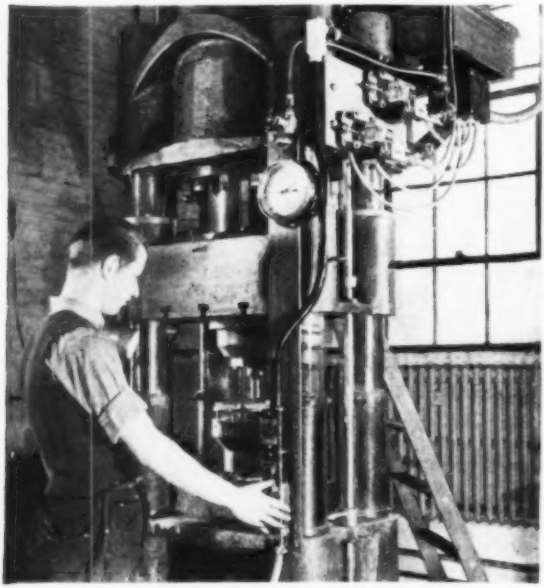
. . . which is then clamped into the frame of the mixing machine. This mixer holds two jar mills



Whirling the jar mills at high speed, the machine mixes the powders thoroughly for even distribution

quantity may be limited to 500 pieces, with economy and advantage both in high and limited production.

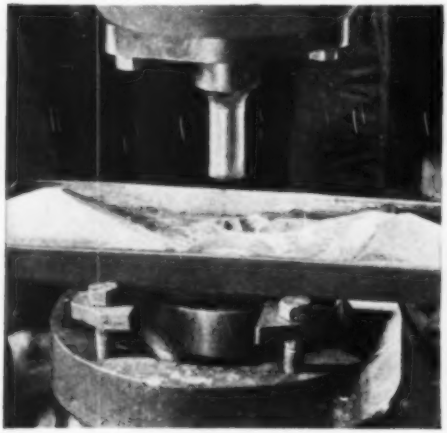
The reducing of metals to powder goes back to antiquity. The Egyptians knew of it, and in medieval times those who wished could indulge the whim of writing with gold and silver inks. Modern methods used for making powder include milling or grinding, machining, electrolytic deposition, condensation of metal vapors, chemical precipitation, embrittling with hydrogen followed by impact pulverizing, shotting (pouring liquid metal into water through air and gas), atomizing (disintegrating by steam and compressed air), and granulation (stirring a molten metal at a point where it is beginning to solidify.) The shape and size of the powder depends upon the method used. The particles may be spherical, dendritic (shaped like snowflakes), flat, cubic, or tubular. The particles may range in size from three to 250 microns—one micron equals .00003937 inches, or one millionth of a meter. One of the largest companies making metal powders in the country goes by the catchy name of Metals Disintegrating Company, at Elizabeth, N. J.



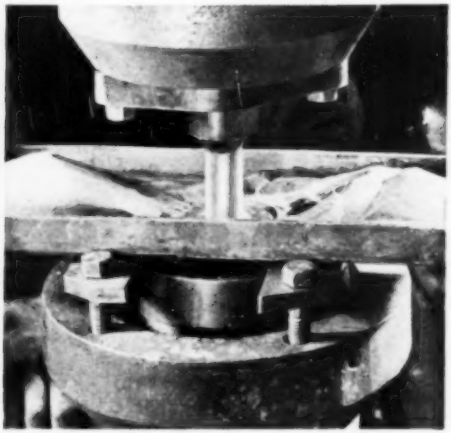
This is one of the powder-metallurgy presses. It can exert a pressure from a few thousand pounds to 200 tons per square inch

The first consideration in pressing the powders is in estimating the amount necessary for a particular piece. Either hydraulic or mechanical presses are used, the amount of pressure varying according to the structure of the product.

Two general types of furnaces are used, the batch type, in which the compressed powders are introduced in batches, like loaves of bread, and the belt-conveyor type. Within the sintering furnace the product must be inclosed in a protective atmosphere, usually hydrogen or



Here the plunger of the press is poised above a tray of the powder mixture. When it descends . . .



. . . it forces powder into the die beneath and applies high pressure to form it into a briquette

burned gas, to prevent oxidation. Sometimes dimensional changes, shrinkage or growth, take place during the sintering and for this reason the amount of heat and the degree with which it is applied must be controlled exactly. For one great advantage powder metallurgy has over casting is in the exact size to which parts can be formed without machining and this advantage can be lost by incorrect heating.

Dr. William D. Coolidge, of General Electric Company, is considered by many experts to have opened the way for modern powder metallurgy years ago when he found a way of making ductile tungsten filaments for incandescent light. Osmium was first used for filaments, the wire being produced by mixing osmium powder with binders, such as sugar sirup, and squirting the mixture through fine dies. Later tantalum and tungsten were substituted for osmium in the same general process. One great fault of the filaments was lack of ductility and the fault remained until Dr. Coolidge found the answer.

In the Coolidge process, tungsten powder was pressed into briquettes which then were worked to produce rods. From these rods wire was drawn of .001-inch diameter and yet with a tensile strength up to 590,000 pounds per square inch. According to E. H. Hall, of Metals Disintegrating Company, if a tungsten wire were to be drawn down to one atom in diameter, its tensile strength, measured as the cohesive forces between the atoms, would be almost 12,000,000 pounds to the square inch. The Coolidge process opened the way for the fabricating of other refractory metals.

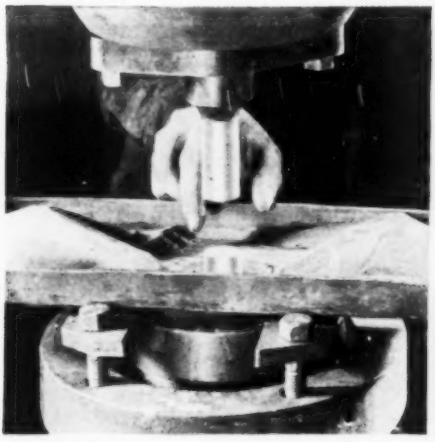
The principal uses of modern powder metallurgy are: in the working of refractory metals, such as tungsten, tantalum, molybdenum, etc.; in combining metal and nonmetallic powders; in the development of structures not practical by other methods, such as the self-lubricating bearing; to provide a more economical means for fabrication of products than can be made by other methods, such as small eccentric shapes and alnico magnets; and to combine two or more metals without appreciable alloying so that their individual characteristics are maintained.

Cemented carbide tools, porous self-lubricating bearings, current-collector brushes, diamond-impregnated grinding wheels, electrical contacts and welding electrodes, and automotive pump gears are among the best known of powder-metallurgy products.

Cemented carbides were invented to take the place of the very expensive diamond dies. Tungsten carbide was found not only hard enough, but when cemented together with cobalt was found also to be tough enough to be used as a cutting tool. The briquettes of carbide and matrix metal are sintered above the melting point of the cobalt which holds the hard carbides together. There are a number of large companies now making such tools, among them Carboloy, a subsidiary of General Electric, Fansteel Metallurgical Corporation, and Firth-Sterling Steel Company, of Pittsburgh.

The field of self-lubricating bearings is considered so important that General Motors has established the Moraine Products Division for this purpose and Chrysler has its Amplex Division. Other bearings are made by the Bound Brook Oil-less Bearing Company, and the Johnson Bronze Company.

Some idea of the importance of this



When the pressure is removed and the plunger lifts, the compressed briquette is ejected automatically

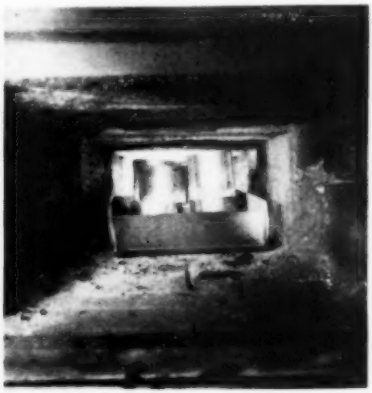
As the pressing operation ends, what went into the die as a loose powder comes out a compacted mass

branch of powder metallurgy can be gained by reflecting that there are as many as 76 porous bearings in a modern automobile. The bearings are pressed from copper and tin powders, to which varying percentages of graphite are added. The degree of porosity may be controlled from a fraction of one percent to about 40 percent by volume. The oil with which these bearings are impregnated is frequently sufficient to last for the life of the machine in which they are installed. Besides in automobiles they are used in washing machines, electric clocks, refrigerators, many small electric motors, and farm equipment.

Current-collector brushes were created to meet the demand resulting from the development of electrical motors and generators for brushes which were not abrasive to the commutators or rings and at the same time fulfilled the requirements for good electrical conductivity.

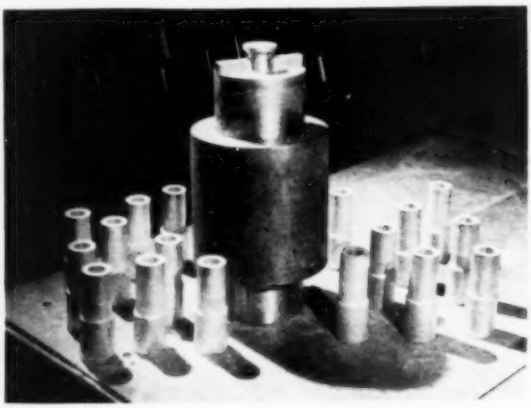
A recent development in powder metallurgy has been a method of producing briquetted and sintered parts from iron powder, which in turn grew out of the manufacture of porous bronze bearings. This has led to the manufacture of an oil-pump gear by powder metallurgy. During the 1940 car year the entire needs of one large automobile manufacturer for oil-pump gears were made from molded iron powder, mixed with graphite powder, which acts as a lubricant in molding. There is not only a great saving in raw materials in the powder-metallurgy operation, but the gear functions much more quietly, by reason of the oil-filled pores at its surface.

The next step is to place the briquette in a furnace which applies heat below the melting point of the metal used . . .



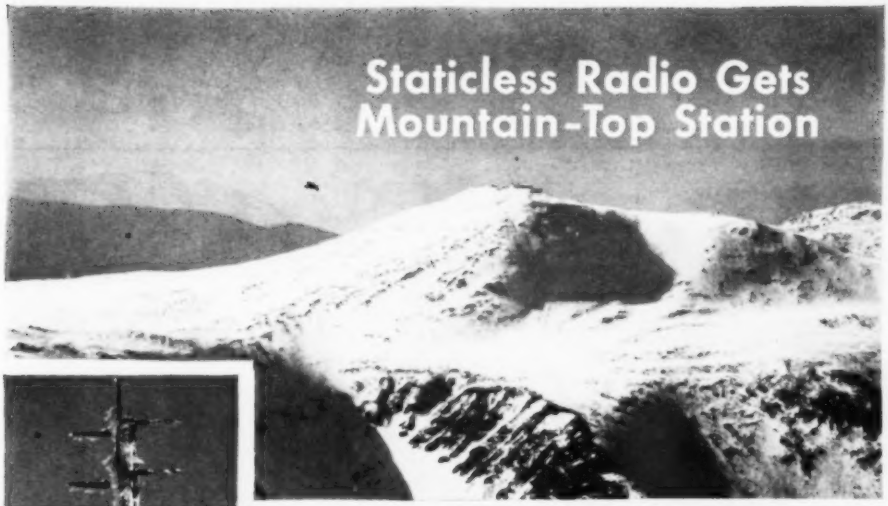
. . . to complete the adhesion of the powder. This is the inside of the furnace

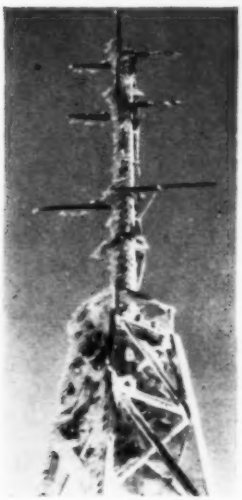
Here the briquettes are being removed as the last step in this remarkable process



Machine parts made by powder metallurgy. Products include self-lubricating bearings, grinding wheels, magnets

# Staticless Radio Gets Mountain-Top Station

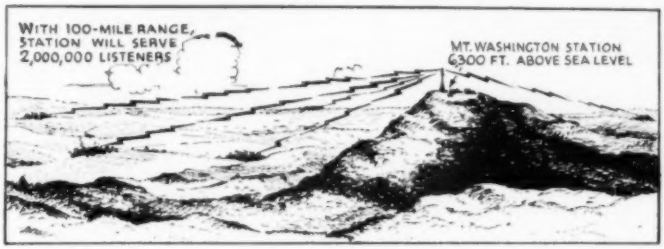




Above, Mt. Washington from the air, and at left, antenna mast at 6,300-foot level

At right, dressed like an explorer, operator Alex McKenzie sends data on the weather to the Boston Office

HIGHEST broadcasting station in the northeastern United States is the Yankee Network's new FM (Frequency Modulation) W1XER, to begin operating commercially as W39B this summer. Because the waves used in FM are limited in range by horizon distance, the station is perched on Mt. Washington, N. H., with its antenna 6,300 feet above sea level. To withstand the gales on the peak, where wind velocities of 188 miles an hour have been recorded, the self-contained power plant and equipment are housed in a building with walls a foot thick. The peak is frequently isolated by bad weather, so two engineers will live in the station. Programs originating in Boston, Mass., will be transmitted to the station by radio and rebroadcast.




Why WIXER sits on the highest peak in New England: Horizon distance limits FM range, so the higher the station the farther it broadcasts

# Here's My Story

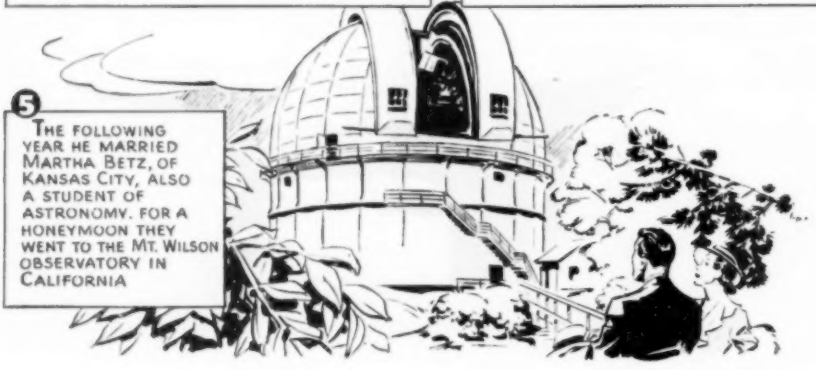
**DR. HARLOW SHAPLEY**, DIRECTOR OF THE HARVARD OBSERVATORY SINCE 1921, WAS THE FIRST MAN TO LOCATE THE CENTER OF OUR UNIVERSE

TO EKE OUT THE FAMILY INCOME AFTER HIS FATHER'S DEATH, HARLOW RAN ERRANDS IN HIS SPARE TIME WHILE ATTENDING THE CARTHAGE, MO., ACADEMY

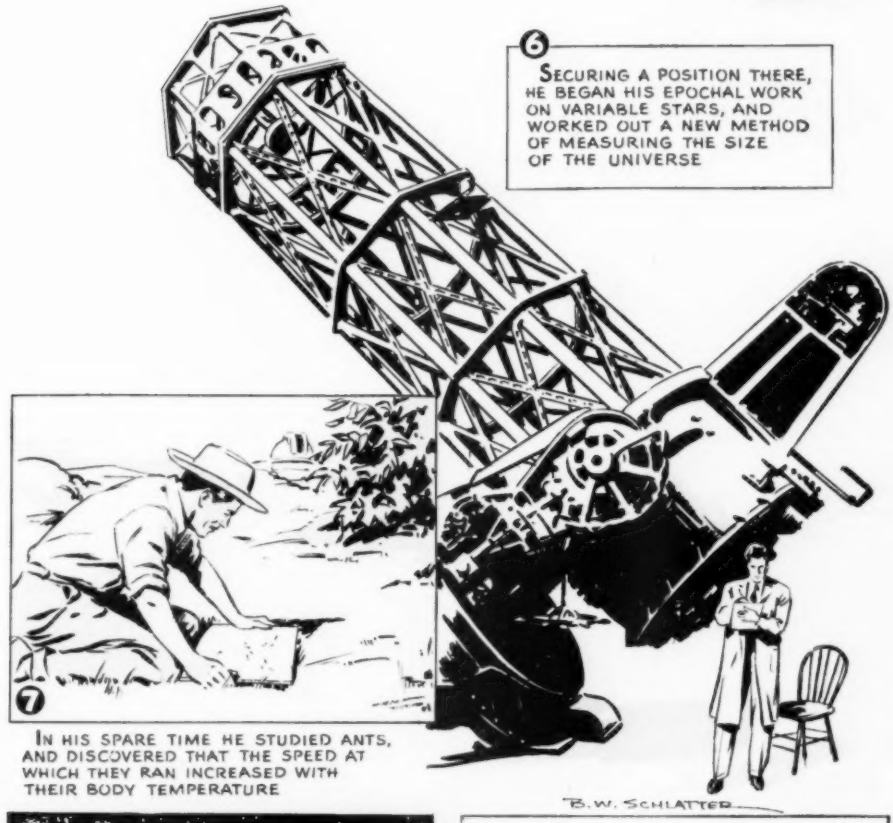
AFTER LEAVING THE ACADEMY, HE WORKED AS REPORTER AND CITY EDITOR FOR THE CHANUTE, KAN., "DAILY SUN" TO EARN MONEY FOR COLLEGE

IN 1906 AT THE AGE OF 20, HE ENTERED THE UNIVERSITY OF MISSOURI. THERE, ASTRONOMER FREDERICK HANLEY SEARES FIRST INTERESTED HIM IN THE STUDY OF STARS

HIS ABILITY IN HIS CHOSEN SUBJECT WON HIM A FELLOWSHIP AT PRINCETON UNIVERSITY, WHERE HE WORKED WITH DR. HENRY NORRIS RUSSELL BEFORE EARNING HIS PH.D. IN 1913


5
THE FOLLOWING YEAR HE MARRIED MARTHA BETZ, OF KANSAS CITY, ALSO A STUDENT OF ASTRONOMY. FOR A HONEYMOON THEY WENT TO THE MT. WILSON OBSERVATORY IN CALIFORNIA

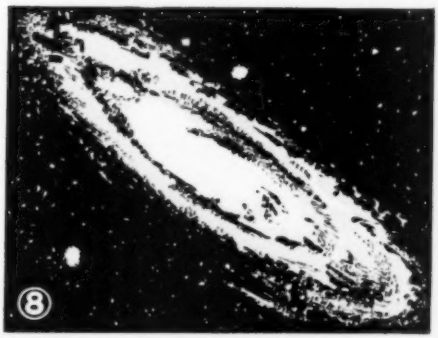
# THE CAREER OF HARLOW SHAPLEY



6 SECURING A POSITION THERE, HE BEGAN HIS EPOCHAL WORK ON VARIABLE STARS, AND WORKED OUT A NEW METHOD OF MEASURING THE SIZE OF THE UNIVERSE

7 IN HIS SPARE TIME HE STUDIED ANTS, AND DISCOVERED THAT THE SPEED AT WHICH THEY RAN INCREASED WITH THEIR BODY TEMPERATURE

B. W. SCHLATTER



8 HIS RESEARCH HAS ADDED MUCH TO THE KNOWLEDGE OF SPIRAL NEBULAE, AND HE HAS COMPILED ONE OF THE WORLD'S GREATEST COLLECTIONS OF ASTRONOMICAL PHOTOGRAPHS

9 AT THE HARVARD OBSERVATORY HE WORKS AT A ROTATING TABLE, SYMBOLIC OF HIS INTEREST IN THE WHIRLING UNIVERSE. AT PRESENT HE IS DIRECTING A MAMMOTH CENSUS OF THE CELESTIAL BODIES

## Basketball "Bumpers" Protect Eyeglasses

"BUMPERS" for basketball players now enable those who wear glasses to enjoy the sport. A transparent guard of unbreakable plastic, cut away to bridge the nose, completely surrounds the spectacles and insures them against being knocked off or shattered if struck. Supported by straps, the headgear is held away from the face by resilient pads resting against forehead and cheeks, and is said not to impair vision. The illustration shows Dick Dikeman, high-school player of Detroit, Mich.

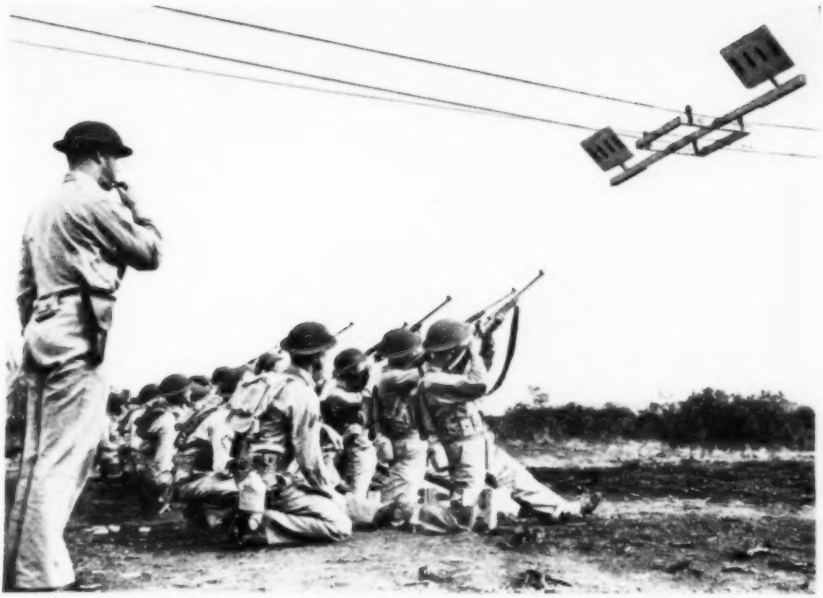
## Sorting Machines Salvage Dropped Rivets in Plane Factory

A WORKER who drives 1,000 rivets a day on bombing or clipper planes, at the Glenn L. Martin factory in Baltimore, Md., has no time to pick up dropped ones. So sixty pounds of aluminum-alloy rivets, worth more than a dollar a pound, are swept up daily. To salvage them, the plant's engineers have devised ingenious machines.

First an electromagnet passes over the floor sweepings to remove screws, bolts, nuts, and anything else made out of iron or steel. Next, the 150 kinds of aluminum rivets go through "sifters" that deposit them in different trays, according to diameter, much as gravel is graded. To unscramble each batch according to length, a second type of sorting machine drops the rivets with heads up into slots on a wheel. As the wheel turns, flaring springs at different levels below it strike the shanks of the rivets and knock them off into the proper bins—longest ones first, shortest ones last. Finally a third variety of sorter separates flat-head from round-head rivets.

Sliding down an incline, rivets fall head up into slots on this revolving wheel. Springs knock them out according to length

The fast-working little machine below separates round and flat-head rivets, dropping them into separate trays



## Moving Target Primes Marines for Dive Bombers

BLASTING away at a target as it rushes down over them on steel cables, U. S. Marines stationed at Camp Elliot, San Diego, Calif., practice at bringing down dive bombers with rifle fire. The target simulates a 1,500-foot plunge of a real plane, taking only six seconds during which each marine gets in five shots. A sergeant times their practice.

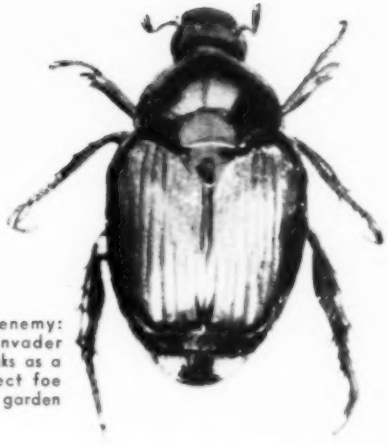
## Loudspeaker System Takes the Classroom to the Sickroom

BEDRIDDEN youngsters in 15 Iowa school districts can listen to their teachers and classmates at school, and also recite their own lessons for teacher and class to hear when called upon. This is accomplished by a two-way loudspeaker system similar to business-type interoffice communicators, with the state furnishing the speakers, microphones, and amplifying units, and the school districts leasing the necessary telephone lines for the service.

From the classroom, the teacher can talk with an absent student, who hears and recites through an instrument installed in his home, as at the right

# All-Out War Declared on Japanese Beetles

## BACTERIA AND FRIENDLY INSECTS ENLISTED AGAINST GARDEN PESTS



This is the enemy: a ruthless invader that now ranks as a leading insect foe of farm and garden

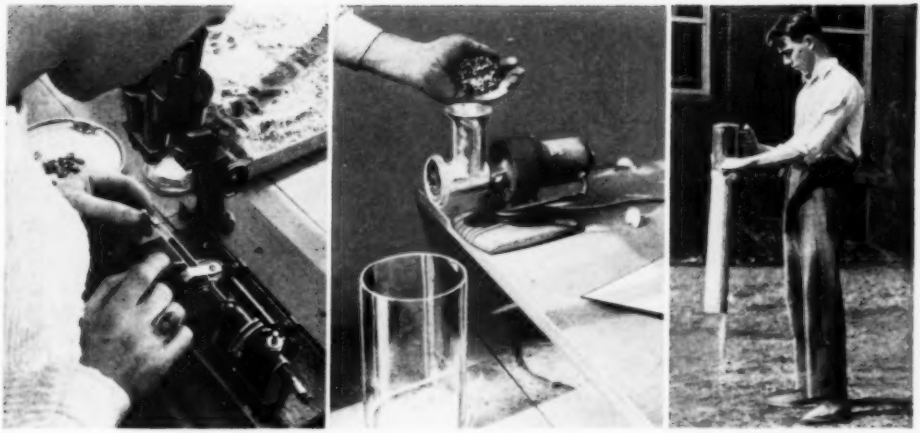
EXACTLY a quarter of a century ago this year, a nurseryman at Riverton, N. J., not far from Philadelphia, noticed some curious, brilliantly marked beetles devouring leaves on his plants. The insects had arrived as grubs on Japanese iris roots. Multiplying at an alarming rate, they spread out into surrounding gardens and farms. At the end of four years, they were a serious pest in the fields over an area of 100 square miles; at the end of seven years, they had increased this foothold to 2,500 square miles. Since, then, landing in advanced positions like parachute troops, the winged invaders have become more strongly intrenched each year. In spite of every effort by state and Government entomologists, the Japanese beetle has taken its place with the boll weevil, the gypsy moth, and the Colorado potato beetle as a leading insect menace to American agriculture.

The latest weapons in battling Japanese beetles include minute bacterial spores and legions of parasitic wasps. At the laboratory of the Department of Entomology at the University of Maryland, Dr. E. N. Cory, Maryland State Entomologist, has been directing the present offensive. In both methods of attack, destroying the grubs or larvæ of the beetle is the objective. These grubs are often so thick in infested regions that as many as 1,500 can be taken from a single square yard of soil. Cutting under the roots of sod, they sometimes leave golf-course greens or even whole lawns so they can be rolled up like a carpet.

The wasp that preys on the beetle grubs is known to science as *Typhia vernalis*. A minute relative of the digger wasps familiar to America, this black, Oriental midget is barely half an inch in length. With uncanny ability, it darts about over infested fields, alights, and deposits its eggs so the emerging wasp larvæ suck the vital fluids from the beetle grubs and cause their death. Then the baby wasps spin cocoons in which they remain until the following spring. Along in May, they emerge as winged adults and the whole cycle in the life of this valuable ally of ours begins again.

Each fertilized female wasp is capable of depositing from 50 to 100 eggs. It takes her about a month to accomplish this task. During the adult life of the wasp, the only

THIS IS HIS PLAN OF ATTACK: The chart below shows the life cycle of the Japanese beetle



"MILKY WHITE DISEASE" is spread among the beetles by inoculating grubs with the bacteria and, after incubation, grinding up the grubs to prepare a powder for sprinkling on infested soil

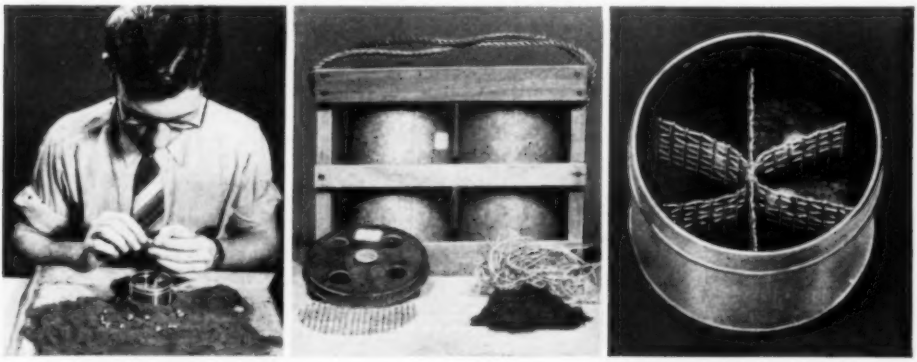
food it requires is the sweet fluid, or honeydew, produced by plant lice. Raised in the Maryland laboratory, the parasitic wasps are being released in colonies of 100 in heavily infested areas.

Even more promising is what has become known as "the milky white disease." About half a dozen years ago, entomologists discovered that in certain infested areas, large numbers of the beetle grubs were dying. The late Dr. G. F. White, of the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, was called in to find the "whys and wherefores." In short order, he isolated the bacteria that were producing the mortality among the grubs. Where the disease came from or how it started, nobody knows. It was given its present name because the infected grubs turn milky white.

Ever since Dr. White announced his discovery, entomologists have been working at top speed to spread the disease through the ranks of their insect foe. Men from the Maryland laboratory collect as many as a quarter of a million healthy Japanese beetle grubs just before the coming of frost in autumn. They are placed in boxes filled with soil, 1,500 to a box, and put in refrigerators where the temperature is 45 degrees F. At this temperature, the grubs remain inactive.

During the winter, the hundreds of thousands of larvæ are inoculated with the dis-

BREEDING WASPS to prey on Japanese beetles. In six-room breeding cans, wasps lay eggs on beetle grubs. When hatched, young wasps are distributed in the large galvanized cans, which hold 300 each



ease bacteria. Serum for the purpose is produced by mashing the abdomen of an infected grub between two microscope slides and then washing off the slides with two centimeters of water. This solution provides sufficient serum to inoculate 500 grubs.

As each box is taken from the cold-storage room, the soil is separated from the grubs with a special screen. By means of a laboratory mechanism which automatically measures the right amount of serum, each grub is inoculated with approximately 2,000,000 spores. Then it goes into an individual compartment in an incubating box. These boxes contain 500 separate compartments, each a cubic inch in size and filled with soil in which clover seed has been planted. During the incubation period, about 12 days, a steady temperature of 80 degrees F. is maintained. The sprouting seed provides the grub with a source of food.

At the end of the dozen days, the two million spores in the body of the grub have increased to three billion. The sick larvæ are then removed and placed in jars of ice water until a sufficient supply has been obtained to proceed with the next step in the process.

This is running the accumulated larvæ through an ordinary meat grinder. The resulting "chum," to borrow a term from the vocabulary of the salt-water angler, is standardized as to spore count by the addition of water. It is then thoroughly mixed with finely powdered chalk in a mechanical dough mixer. After being rapidly dried to prevent decomposition, this "dough" is powdered and talc is added to provide bulk for handling. It is then stored in sacks, each sack holding a pound and three quarters, the amount required for the adequate treatment of a whole acre of ground.

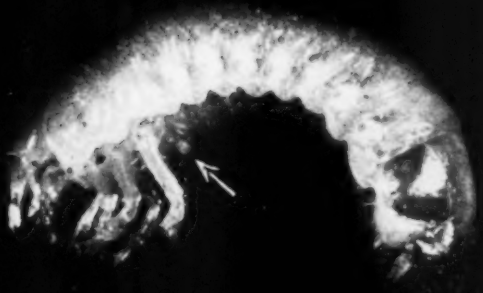
Our insect ally is "Typhia vernalis," an Oriental wasp. What it does to beetle grubs is shown on opposite page

→

In applying the powder to infested areas, an instrument which suggests a hand corn planter is employed. Every time a lever is pressed, the device deposits two grams of the powder. Deposits are made every ten feet, the wind and rain spreading the spores out in all directions. Twenty-six inoculated grubs in the laboratory produce the 78,000,000,000 spores needed to treat an acre. If these spores do not come in contact with grubs the first year, they may the second, or the third, or fourth. They are known to remain virulent for at least four years and may retain their power even longer.

These deadly spores, together with the egg-laying activity of the Oriental wasp, *Typhia vernalis*, are expected to stem the destructive rising tide of the Japanese beetles.

Workers in a Maryland laboratory packing beetle grubs on which wasps have laid eggs. The eggs hatch out during the winter, and by spring winged adult wasps are ready



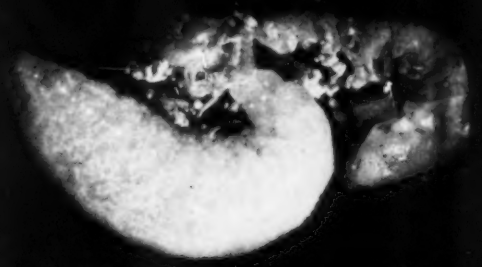
The wasp deposits its eggs behind the grub's legs

In six days the wasp larva has hatched out and . . .

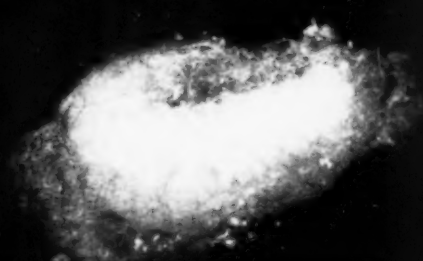
feeds by sucking the body juices from the grub

Ten days after hatching, the larva is almost mature

In fifteen days, it has killed the beetle grub . . .



and proceeds to consume the hollow outer shell



Finally the larva spins a cocoon and in ten days . . .

is an adult wasp ready to emerge the next spring

4
4
JOHN T. McCOY, JR.

# AMERICA'S AIR HITTING POWER

*Defense of the Western Hemisphere Calls for Many Long-Range Bombers To Strike at an Army of Invasion Before It Can Approach Our Shores*

**By C. B. ALLEN**

THIS country's exponents of an independent striking force of the air, coequal with the Army and Navy, subscribe to the fighter's traditional adage that the most effective defense is a vigorous offensive. Translated into terms of safeguarding the Western Hemisphere from foreign attack, this means that they believe in employing long-range bombers of the "flying fortress" type to *prevent* any invasion of the New World instead of attempting to deal with it *after it has occurred*. Consequently, they look with grave foreboding upon a national policy—so far as the United States can be said to have formulated one—which ignores this principle in practice though accepting it in theory.

Even the present world crisis, with its brutally clear lessons on the effectiveness of air power, has not served to clear the public mind, or the minds of those directing our defense program, of dangerous misconceptions concerning this new form of warfare. There is no lack of either popular or official support (clamor might be a more descriptive term) for "a strong air force." But the prevailing conception of this, among all but the nation's airmen, is, unfortunately, a rather vague picture of swarms of airplanes darkening the skies. It is a comforting picture to those who have it—or would be, if only the airplanes would materialize—because they still visualize air warfare as a battle in the air between opposing aircraft and not as *warfare waged from the air*.

The first and the latest of the U. S. Navy's long-range bombers: At the top, the old NC-4, which made the historic flight from Newfoundland to Europe by way of the Azores on May 16-27, 1919, with Commander Albert C. Read and crew. Below it is today's PB2Y patrol bomber

The heroic and spectacular performance of the Royal Air Force in the "Battle of Britain" probably has strengthened the American public's misunderstanding of what constitutes real air power. In its admiration for the daring and courageous air fighters, who were officially admitted to be the only thing standing between Great Britain and complete disaster after Germany began her aerial blitzkrieg, the public has almost completely lost sight of Britain's dire need of a greater air striking force—hundreds and thousands of bombers to blast German flying bases and hammer, far inland, at the heart of her industrial war economy.

Too many people, some of them sitting at our own defense councils, have been led to forget that the British problem of coping with air attack is totally different from that of America, and this has added to the confusion of our already muddled air-defense thinking and planning. Merely because Spitfire and Hurricane pursuit planes were England's salvation in the early days of Hitler's "total" air war, it does not follow that America's safety lies in building swarms of pursuit ships. Yet our Western Hemisphere defense plan, as laid down by the Army's General Staff, and approved by the President, called for 35 percent of all the airplanes involved to be in the pursuit category Champions of real air power, as applied to American defense needs, viewed that proportion as appalling. However, there is reason to believe that it is now being scaled downward.

"The pursuit plane," said one Army airman recently, "is, like the Army itself, invaluable for the close-in defense of our borders, but it does not contribute one iota to the air power of this nation. Air power is proportional to numbers *and types*, not to numbers alone. Fifty thousand pistols are useless compared to a single rifle at a thousand yards range. The pursuit plane is the pistol of the air, while the long-range bomber corresponds to the rifle. Why wait for your enemy to get within pistol range, particularly when you enjoy a geographical position which makes it impossible for him to use even his rifles against you until he does?"

Long-range, four-engined bombers of the "flying fortress" type, with an effective op-

erating radius of 1,000 to 1,500 miles, are the backbone of the independent air striking force, as conceived by the proponents of a coördinated land, sea, and air defense program. They would be supplemented by shorter-range medium bombers in somewhat larger numbers, with an operating radius of 500 to 750 miles, and by light attack bombers with a 250 to 375-mile radius, as a third line of aerial offensive-defense.

The theory of the employment of these three types is that they would attack enemy warships, aircraft carriers, and troop transports, three, two, and one sailing days respectively, from the coastline or advanced bases whence the bombers were operating. It is self-evident that the nation's "air frontier" is extended under this system by just so many sailing days as its air base outposts are distant from the mainland.

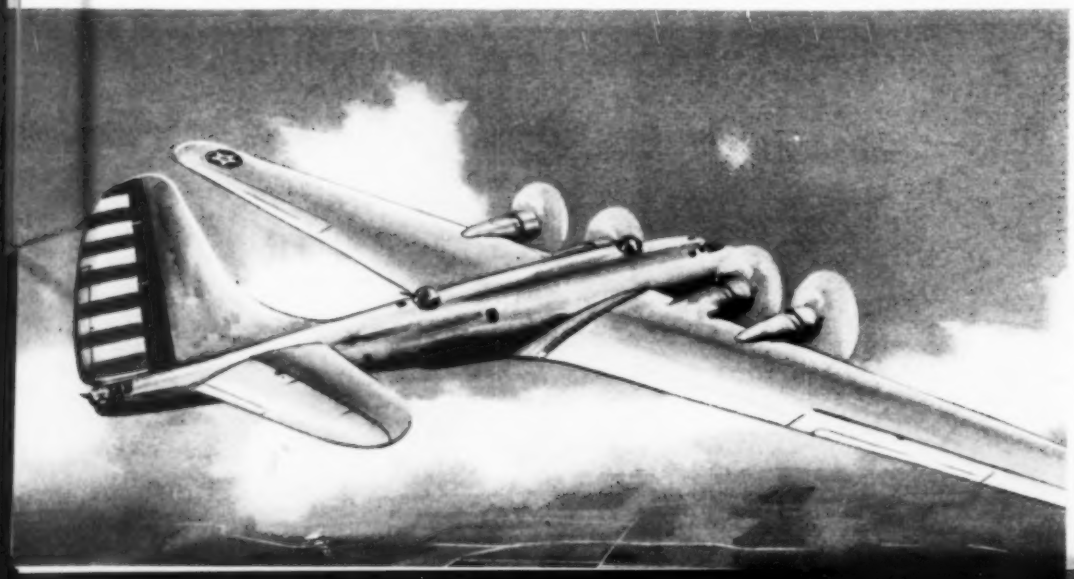
One tremendous advantage enjoyed by the flying fortresses, and shorter-range bombers now being built to supplement them in this type of air warfare, is that they will be faster than any carrier-borne foreign pursuit plane, so far developed, which might be brought into action against them at sea. Thus, they are virtually invulnerable to air attack so long as they succeed in their fundamental mission of preventing enemy air forces from reaching and establishing themselves in New World bases. This advantage, of course, will be lost in the case of the flying fortresses released to Great Britain, which will be exposed to swift, land-based German pursuit ships having a substantial edge on them in speed.

In order for an aircraft carrier's planes to attack seaboard objectives, it is necessary for the mother ship to launch them close enough inshore so they will have sufficient fuel not only to carry out their mission, but to overtake and rejoin the carrier as she steams back out to sea. Roughly, the offshore launching distance figures out to 300 miles. Since a carrier can cover approximately the same distance in a ten-hour night's run, it is obvious that such a vessel must not be more than 600 miles from her objective by sundown of the preceding day, assuming that her planes are to be launched at dawn. Consequently, a thorough daylight air patrol of the 600-mile zone insures a one-day warning of such an attack, if not the certain destruction or disabling of the carrier; while a 1,200-mile patrol provides a two-day safeguard. In either case, of course, bad weather and poor visibility might enable a carrier to slip in and deliver a serious attack.

Air-defense tactics of this nature already have been worked out by the General Headquarters Air Force of the Army, which was created several years ago as a half-hearted step in the direction of an independent striking force of the air, but is still subject to the limitations imposed upon it by a ground command. Such tactics would be put into as full-scale effect, in the event of war, as the limited flying equipment now possessed by the G.H.Q. Air Force would permit, and presumably would be coördinated with offshore patrols of the Navy's air force.

However, the Army and Navy high commands hold many divergent ideas concerning the employment of aviation in warfare; known jealousies exist between the two services, and there is too little assurance of the most effective air teamwork possible between them if a real defense crisis occurs.

Biggest plane in the world, the U. S. Army's B-19 could fly to Europe, drop bombs, and fly home again

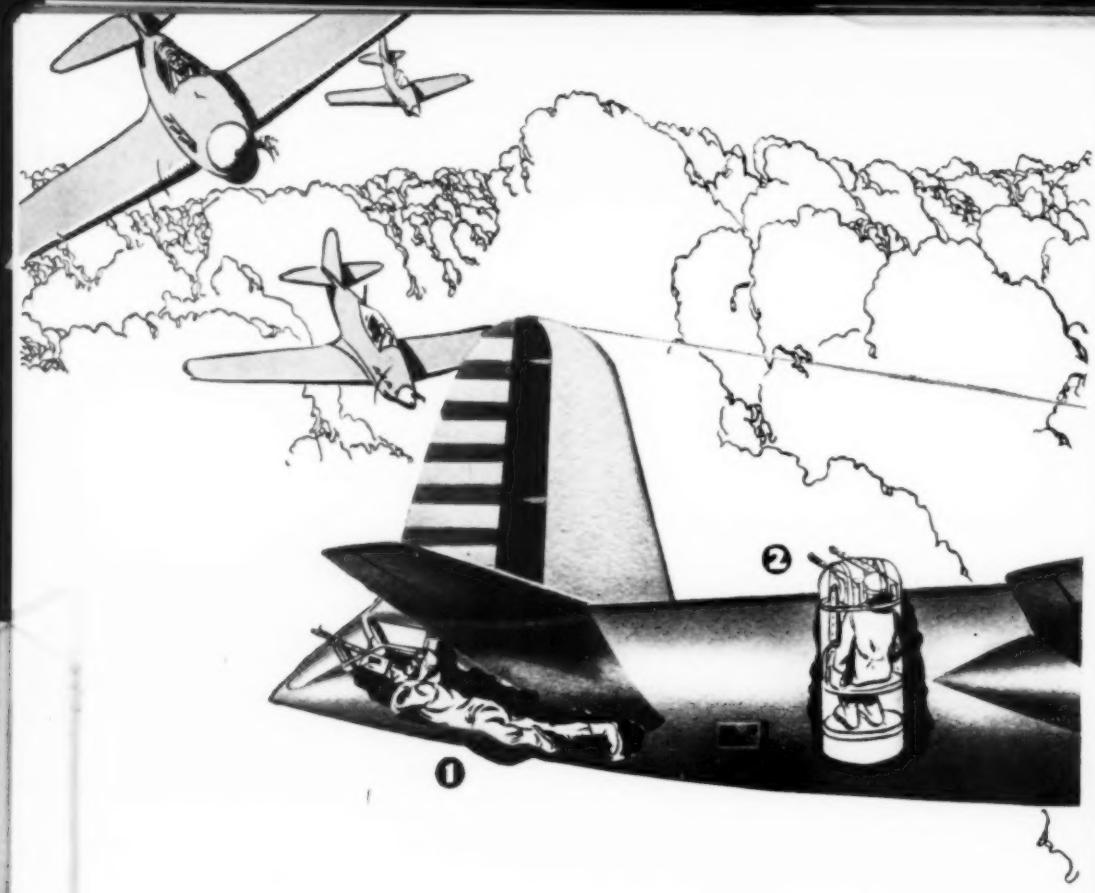


This should not be construed as any slur at able and efficient officers who head both the Army and Navy; it is simply an appraisal of their unswerving devotion to the traditions of their respective services and of their limited-horizon concept of air power as still being in its swaddling-clothes role of an "auxiliary service" to land and sea forces.

Accepting the fact that America's air power, for the present, is still controlled by men without thorough understanding of either its limitations or possibilities, an examination of the country's present and projected air strength, together with plans for its use in a real national emergency, would seem to be in order. At the moment, the Army has approximately 3,000 airplanes of all types, including training ships and obsolete combat planes; the Navy total is about 2,500. By July 1942, under plans approved by the National Defense Advisory Commission, the Army is scheduled to have an overall total of 18,000 planes and the Navy 7,000.

Nearly half of the Army's proposed 18,000 airplanes will be trainers, because the Air Corps faces the necessity of turning out five times the number of pilots it started with last summer, as well as acquiring five times the number of aircraft then on hand. Corresponding Navy proportions are somewhat lower, because the Navy traditionally manages to keep abreast of its current needs better than the Army, with the result that its air force is not undergoing so extensive an expansion. The Army's present strength in *combat planes* totals about 1,300; of these 1,000 are obsolete types by our own standards, and the other 300 would be "suicide crates" in Europe's war because they are not yet equipped with protective armor plate for the crews, or

Evolution of the modern Army bomber. Top to bottom: early Martin (1919 to 1927); Keystone (1927 to 1932); Martin B-10 (1932 to 1940); and the new B-26 high-speed bomber




self-sealing fuel tanks, and because they lack adequate gun power.

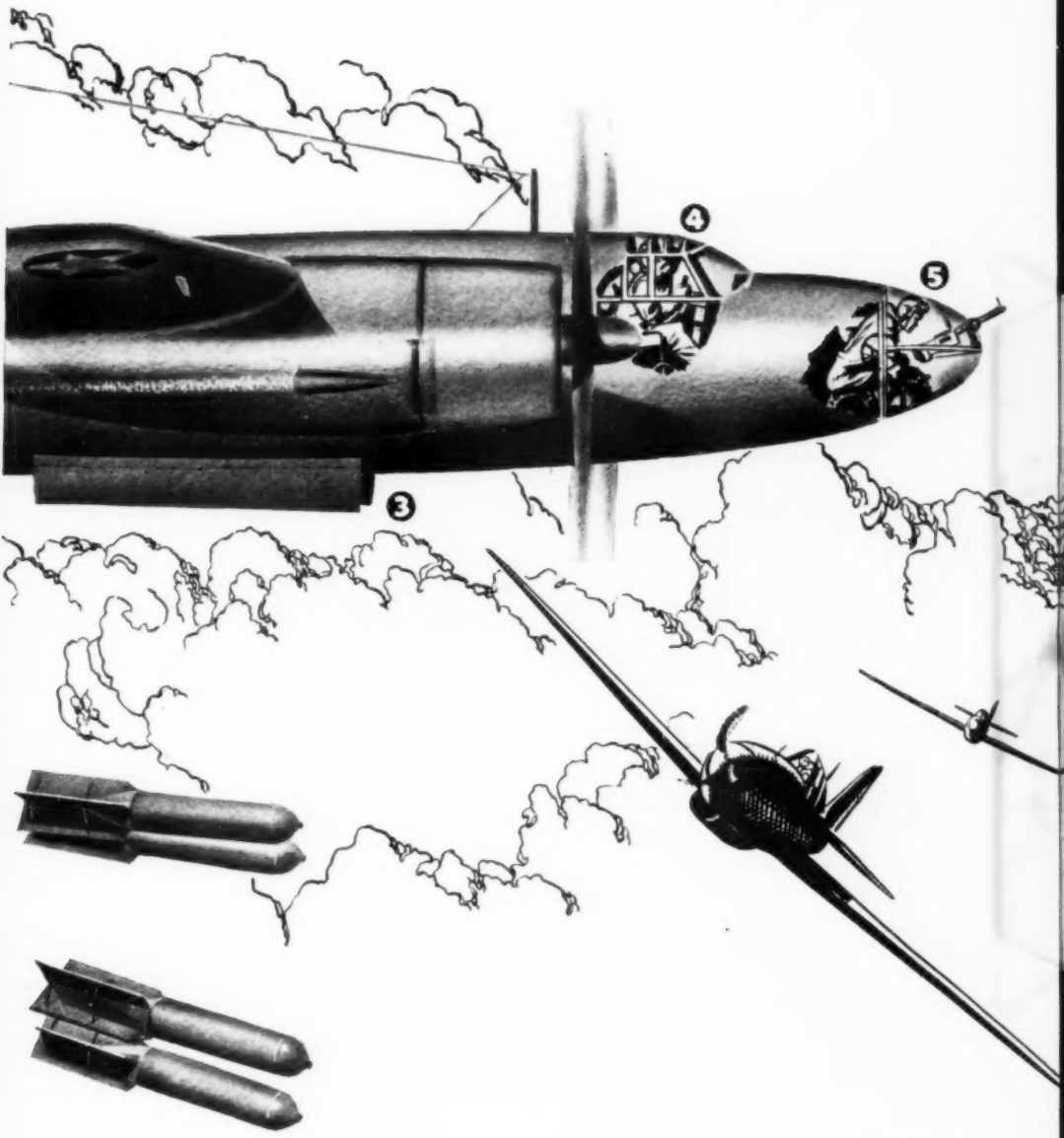
A breakdown of the Army's strength in combat aircraft "on hand and on order" shows that it now has, in round numbers, 100 long-range, four-engined bombers as a nucleus for its projected fleet of at least 1,000 such ships. In the two-engined medium-bomber class, it has 350 ships of a woefully outmoded type, and plans for 1,500 such craft of modernized design and performance. In the light attack-bomber field it now has nothing at all, but has placed orders for 1,200 twin-engined craft of this type. On the pursuit front, the Army could muster some 650 obsolete ships and 200 of modern design—barring the fact that they have not yet been brought up to the European standards previously mentioned—and expects to have a total of 2,000 to 3,000. In the non-combat field, it is interesting to note that the Army, profiting from lessons learned in Europe, will procure 2,000 twin-engined observation planes to replace present single-engined ships of this type now considered useless in modern air warfare.

Besides training and combat types, the Army's plans call for some 500 transport planes of either the four-engined or super-twin-engined type, capable of carrying 20 soldiers each, with full arms and equipment for 24 to 36 hours combat operation, on nonstop flights of 1,500 miles. These aircraft, however, probably won't be delivered until 1943. What they will mean is the ability to concentrate a highly trained land force of 10,000 men on short notice at any "danger zone" in the Western Hemisphere where suitable landing fields are available.

Hence the importance of the various air bases which the United States is now striving to acquire at strategic points throughout the New World. Anyone with a map and a ruler can figure out about how many such bases are needed and where they should be located. Nor does it require a military master mind to see the seriousness of allowing a hostile force to establish itself at such bases within air striking distance of the United States or its defense outposts.

## ARMY'S NEWEST MEDIUM BOMBER OUTFLIES MOST PURSUIT PLANES

"FASTER than most of the pursuit ships now fighting in Europe," is the way U. S. Army officers describe the 26,625-pound Martin B-26 medium bombing plane. Powered with two 1,850-horsepower Pratt and Whitney 18-cylinder air-cooled radial engines, it has a speed of about 350 miles an hour and carries a crew of five. Drawing shows (1) tail gunner, (2) gunner in power-operated turret, (3) open bomb bay, (4) pilot and copilot who serves as navigator and radio man, and (5) gunner-bombardier.




Matt Greene

# Navy's Miracle Motor Is Direct Descendant of Famous 1917 Liberty

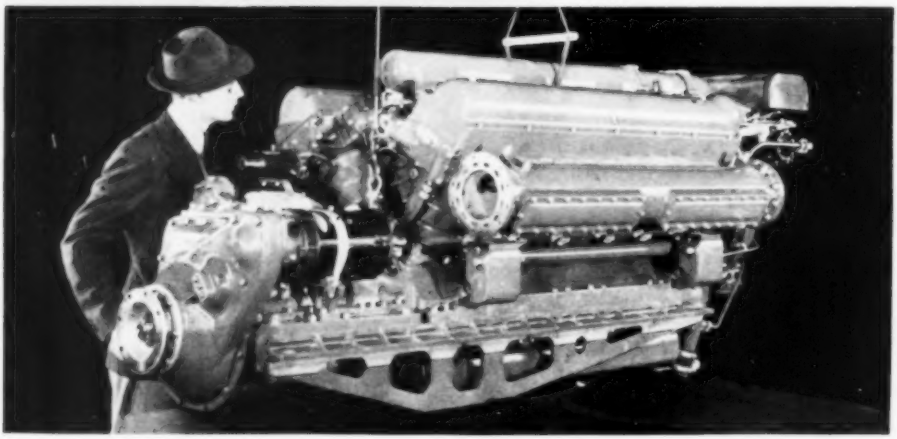
THERE'S no other engine just like it. With minor changes it becomes a top-flight airplane engine. It boasts many illustrious ancestors, including the famous Liberty Motor. It powers the Navy's fastest boats.

It is, prosaically, the Packard 4M-2500 Marine Engine.

As rapidly as the manufacturer can fill its contracts for 700 of the engines, they are being installed, three to a boat, in the Navy's 60-mile-an-hour Motor Torpedo Boat fleet, or shipped to Canada for similar Dominion and British craft.

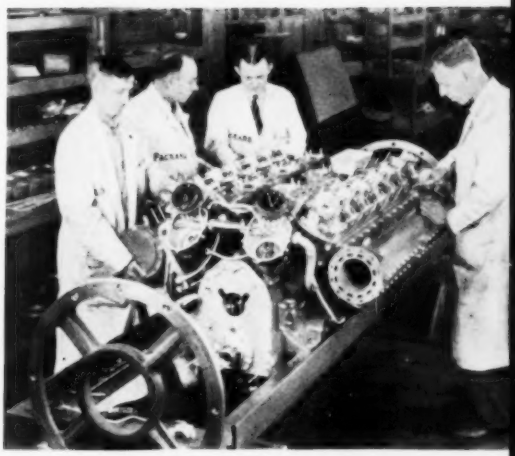
When the United States entered the World War back in 1917, we were caught without a plane motor suitable for quantity production. Colonel, then Major, J. G. Vincent, Packard vice president of engineering, hurried to Washington and laid before the

In 1917, workers were proud of production on the Liberty Motor. Before the war ended, Packard built 6,500 of them



The current representative of the same family, the Packard 4M-2500 also is being built in quantity for a national emergency. It is being installed, three to a unit, in the Navy's 60-mile-an-hour torpedo boats

Assembly-line production of the World War No. I Liberty, near the site of production today of . . .



. . . another potential history-making engine, remarkably similar to it in many of its parts

Aircraft Production Board his plans for a new plane engine, evolved from the Packard Twin-Six introduced two years before.

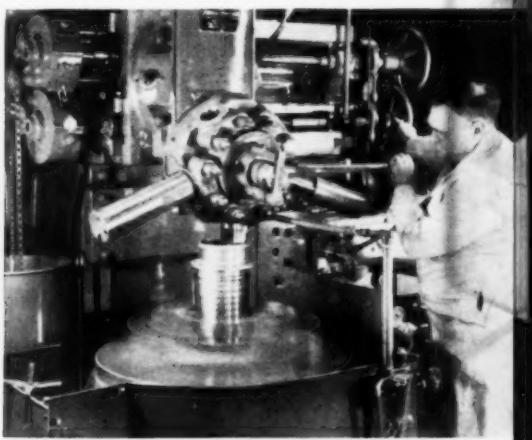
Colonel Vincent and E. J. Hall of the Hall-Scott Motor Company of San Francisco five days later had pooled their ideas and designed the Liberty, closely following Packard's patterns. Packard built 6,500 of them.

Not long ago, history repeated itself when Colonel Vincent again took to Washington his plans for a motor to power planes for the nation's air-defense program.

While it lost out to the Americanized British Rolls Royce, it created a sensation. Modified, it became an engine ideally suited to fast Navy patrol boats for coast defense. Turning up 1,350 horsepower at its "emergency speed" of 2,500 revolutions a minute, it is probably the lightest engine per horsepower ever used in a boat, with a weight-to-horsepower ratio of less than two to one. If a chart were made of the advances pioneered between the Liberty and the 4M-2500, the logical evolution of the latter's design would show in dozens of parts.

After the World War, much credit for the victory was given to the Liberty Motor. Many see promise of new laurels to be won by the Liberty's direct descendant in possible future conflicts.

Experts note, for example, resemblance between these and the Liberty's water-jacketed cylinders



Here a vertical turret lathe bores a marine-engine cylinder much as the Liberty's was made

*Photographs by Knopf*

# Danger is a Diver's Business

## But Thrills and Adventure Are Merely Part of the Job

**By EDWIN TEALE**

HEADLINES in the daily press feature the adventure of deep-sea diving—the romance of sunken galleons and the heroism of work around disabled submarines. There is another side of which the average reader knows little. In the United States, between 3,000 and 5,000 commercial divers, day after day, go to work at the ends of life lines and air hoses. To them danger is a daily routine. Their underwater tasks include everything from entering flooded coal mines and cutting massive steel girders to placing dynamite and hunting for lost diamond rings.

In recent weeks, stepped-up naval expansion and war-stimulated construction have brought a boom in commercial diving. Wherever foundations for skyscrapers, shipways for dreadnoughts, piers for bridges

Walter Russell, 32-year-old diver, prepares for a winter dive. After pulling on heavy felt bootees . .

. . . he slips into his diving suit, helped by his tender, Andy Filyuk. They work as a team

Now comes the rubber suit. Dressing normally takes 15 minutes, can be done in eight in an emergency

Andy puts the heavy metal breastplate, which is to hold the helmet, over Russell's head . . .

. . . and tightens the wing nuts that seal breastplate and suit together as a water-tight unit

Ready for his helmet, Russell has a last smoke. His complete outfit weighs nearly 200 pounds

Walking a plank to a pier where work is going on, the diver looks like an overstuffed bear

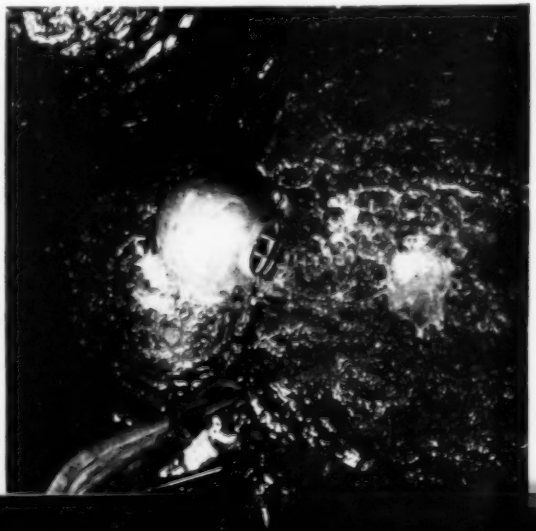
Now the manila life line is carefully fastened to the suit. It can withstand a strain of 1,000 pounds

Over his head goes the 45-pound copper helmet. It is screwed tightly onto the breastplate . . .

. . . and locked in place with a heavy pin. The hose brings in air at a pressure of 40 to 50 pounds

After a final inspection, Russell goes down the ladder, which ends just beneath the surface . . .

. . . and vanishes in a swirl of bubbles. In pitch darkness beneath the surface, he works by "feel"



are under construction, there divers are in demand.

Although one eastern company has as many as 100 divers at a time on its payroll, commercial diving is mainly a free-lance proposition. Individual workers find their own jobs. A few own diving outfits. The majority are supplied with outfits by the contractors who hire them. Only two concerns in the United States, one in New York and the other in Boston, make diving outfits. Complete with an air pump, such an outfit may cost as much as $1,200. The heavy copper helmets can be used for decades. The cloth-and-rubber suits, however, wear out in from three to nine months.

The men who wear these suits get, according to union scale, $20 for an eight-hour day in water not exceeding 60 feet in depth. The time consumed in dressing and undressing, about half an hour for each operation, is included in the eight hours. When working in water deeper than 60 feet, the diver gets a bonus of ten cents a foot per day down to 75 feet; 20 cents a foot between 75 and 100 feet, and 40 cents a foot between 100 and 125 feet. If a diver makes only a five-minute dive, it counts as a day's work. On a one-shift job, if he makes one additional dive after his eight hours are up, it counts as another day's work with double pay for overtime, so he gets the equivalent of three full days' pay.

Wages are good, but he earns them. A diver has to know something of a dozen skilled trades. He must understand pipe fitting, carpentry, rigging, structural iron work, dock building, concrete work, and handling dynamite. And he must be able to apply his knowledge oftentimes under adverse conditions.

Without fanfare or spotlights, the commercial diver goes about his underwater tasks. His is a workaday job. But, it is a job in which excitement and danger always are just around the corner. A few weeks ago, a diver on the bed of the East River, in New York, signaled for the lowering of a huge iron pipe. It was almost within reach when it suddenly shot upward. Then it plunged downward, soared upward, gyrated crazily minute after minute. The diver came to the

With his helmet off, Russell rests between dives

Going down for another dive. Underwater jobs may include the use of cutting torches, dynamite, and pneumatic saws. Russell once balanced himself on a cable while sawing a pile

Rubber mittens keep the diver's hands warm. With the rings and clamps, they cost about $12 a pair

On a belt Russell wears 12 five-pound lead weights. They are removable so the weight can be adjusted

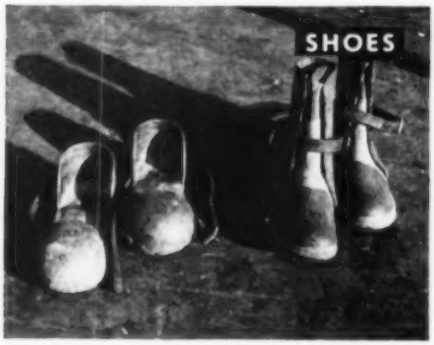
surface at top speed. There he found the wake of a passing Navy mosquito boat had set the derrick barge rocking wildly.

Another diver, who came down on a steep slope, started a submarine landslide which buried him in muck and ooze. Shutting off the air-escape valve, he inflated his suit, at the same time signaling his tender at the surface to heave on the life line. The combined buoyancy of the suit and the upward tug of the tender sent him bursting like a balloon out of the imprisoning silt. The ordinary life line used by divers will stand a strain of about 1,000 pounds; an air hose, 800 pounds.

Besides handling the life line and air hose, the diver's tender assists him in dressing. According to the union scale, his pay is $10.50 a day. Divers and tenders usually form teams like racing drivers and their mechanics. They work together for years and often develop elaborate "shorthand" signal systems based on jerks and wiggles of the life line and air hose. A new supersensitive telephone, recently introduced, has simplified communication. Because compressed air affects the vocal cords, making a baritone sound like a soprano, such telephone systems are tuned to a lower pitch.

Another curious effect of the compressed air on some human systems eliminates about 1/25 of the men who try out diving. No sooner do they get depth than they begin singing at the top of their voices. Bubbles, rising to the surface, show they are following a zigzag track along the bottom. The excess oxygen in the compressed air literally makes them drunk.

Most divers are thin, because wiry men are less susceptible to the bends, the dreaded disease of underwater workers. As a diver descends, the increasing pressure dissolves the inert nitrogen gas in his system.




On his feet he may wear 35-pound iron sandals like those shown at the left, or heavy rubber overshoes

Through these lines, attached to outlets in the wall of the pump house, air is fed to two divers

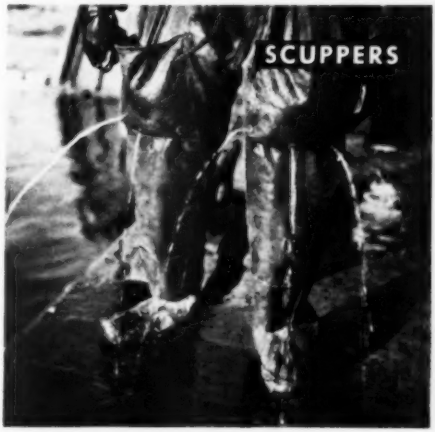
If he ascends too fast, the blood cannot liberate the nitrogen bubbles fast enough and they lodge in the body tissues, causing intense pain. Old-timers believed that drinking quantities of beer would cure the bends. Nowadays, placing the sufferer in a pressure chamber supplied with extra oxygen is recognized as the most effective remedy.

A sure way to unleash a diver's most picturesque vocabulary is to remark how cool it must be on the bottom of a lake during a sweltering summer day. The truth is that heated air, pumped down from above, makes the conditions even worse than at the surface. Moisture from perspiration produce conditions akin to those you feel when wearing a rubber raincoat on a hot and humid day. Sometimes, divers pour as much as a quart of sweat from their suits after such a descent.

In midwinter, moisture in the air line presents quite a different problem. One February day, in Long Island Sound, a diver was cleaning out a huge intake pipe at a power plant. He had been down for half an hour when he signaled for more air. The pump man put on extra speed. A moment later the pressure went away up; the pump wouldn't budge. The tender swiftly hauled the diver to the surface. A dozen feet above the helmet, the hose began rising like a stick straight up into the air. Moisture in the hose had frozen into two solid icicles, each nearly six feet long.

While such unexpected events bulk large in the diving game, most commercial divers pride themselves on not taking risks. In fact, one eastern diver, who is famous for tackling the toughest jobs that come along, always drives in from the country and parks his car on the outskirts of the city. It's too risky to drive through New York!

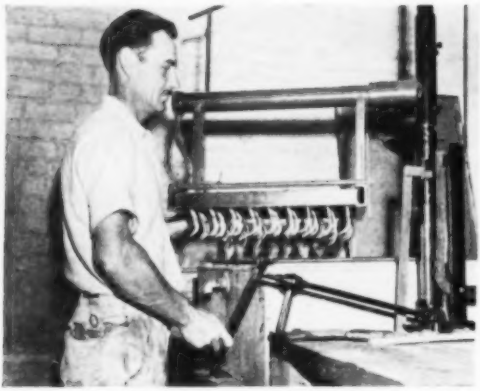
By tapping a pipe, Russell tells men above how to move it. One tap means east; two, south; and so on



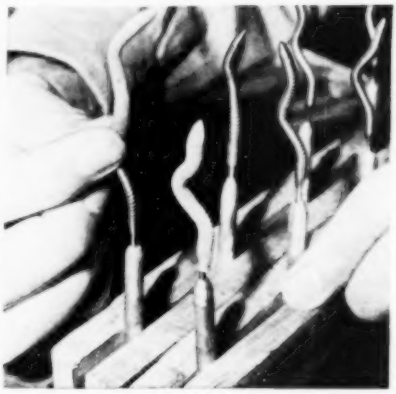

Chafing overalls worn over the suit for protection have pockets with eyelets to drain water on rising

Through a tiny microphone and receiver installed in his helmet, Russell can talk to his tender . . .

. . . while Andy, at the other end of the line, can stand 15 feet away from his microphone and answer



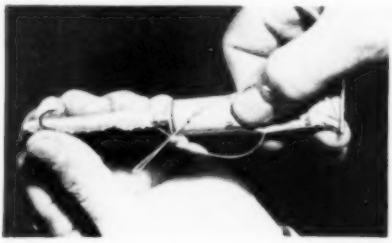
Making rubber bait: this rack of molds shaped like big grubs is about to be lowered into a tank of hot latex



After four dippings, the rubber "worms" are stripped off the stainless-steel molds . . .

## Angleworms Molded from Rubber Make Suckers of Poor Fish

FISH are not hard to fool, according to a California Izaak Walton who has devised bait made of latex. To shape the bait he uses stainless-steel molds resembling worms, grubs, and other natural fish food. The molds are dipped in hot latex, then placed in an oven to harden the material. After the bait forms have been slipped from the molds, hooks and leaders are inserted in them, and they are then filled with a paste flavored with fish eggs.



Hooks and leaders are inserted, and the bait is filled with a paste to tempt fish palates

Workers polishing a finished mural formed of pieces of colored concrete

## Jig-Saw Murals in Colored Stone Adorn Buildings

OPUS SECTILE, the art of creating pictures with carefully shaped blocks of colored stone or concrete, has been used by a California Federal Art Project to make murals for public buildings. One of the completed works, recently installed in the Oakland, Calif., courthouse, weighed 2,100 pounds. Because the colors in these murals are in the stone itself, they can be used in locations exposed to sun and rain as well as for interior decorations.

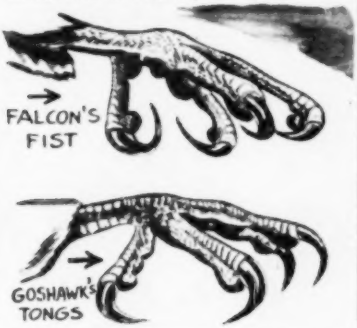
# Un-Natural History

BY *Gus Mager*

THE LITTLE HIMALAYAN **MUSK DEER** SPORTS CANINE TUSKS — TO FIGHT OFF EAGLES!

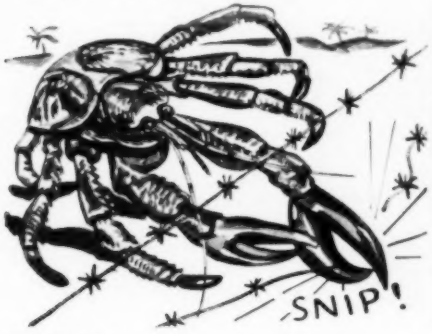
**"MAGNETIC" ANT HILLS** THEY CALL THESE STRANGE WEDGELIKE STRUCTURES IN NORTHERN AUSTRALIA, BECOME THEIR NARROW SIDES ALWAYS POINT NORTH AND SOUTH!

**FALCONS** KILL WITH A BLOW OF THE HALF-CLOSED FOOT, RETURNING AFTER THE KNOCK-OUT TO PICK UP THE VICTIM! BUT THE **GOSHAWK** KILLS BY DRIVING HIS TALONS INTO THE VITALS OF HIS PREY!



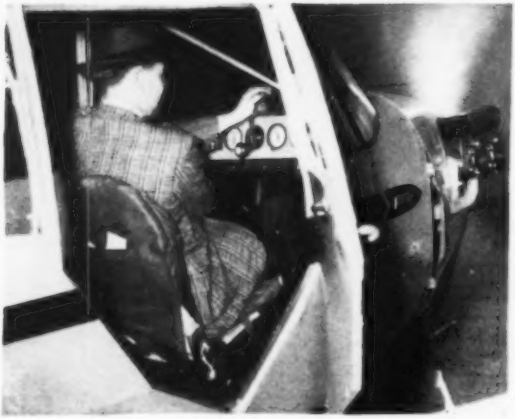
THE **OSTRICH** HAS A KICK LIKE A MULE — EXCEPT THAT THE MULE KICKS BACKWARD, WHILE THE OSTRICH KICKS FORWARD!

THIS RED **LAND CRAB**, OF CHRISTMAS ISLAND IN THE INDIAN OCEAN, PACKS A PAIR OF PINCERS THAT CAN CUT THROUGH WIRE AS EASILY AS PLIERS!

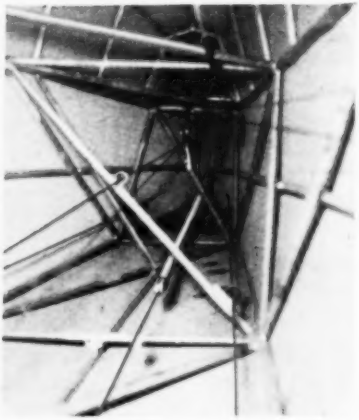


TO WOO HIS LADY-LOVE, THE **ADELIE PENGUIN** TAKES A SMALL STONE AND LAYS IT HUMBLY AT HER FEET!

## Rubber Cord Used as Self-Starter for Light-Plane Engine



William Strohmeier is touching a switch which will release a rubber cord, twisted 30 times, and start his plane engine



The cord, like a rubber-band model motor, is attached to the rear of the fuselage

USING the principle of the rubber-band-powered model, William Strohmeier, of Lock Haven, Pa., recently demonstrated a new lightweight self-starter for engines on private planes. By turning a crank on the instrument panel of his Piper Cub monoplane, Strohmeier winds up a rubber shock-absorber cord that runs the length of the fuselage. Thirty turns of the crank stretches the cord to the required tension. When the energy of the taut cord is released, it spins a metal inertia plate attached to the motor. This turns over the engine and starts it firing. The ingeniously simple arrangement makes the dangerous operation of spinning the propeller to start the motor unnecessary. The mechanism can be used with any type of light-plane engine.

Strohmeier cranks up his starter. A bell rings when the cord is twisted enough to spin the engine twice

## Man Without Vocal Cords Talks with Aid of Throat Vibrator

IN SPITE of the fact that his vocal cords had been removed during an operation nearly nine years previously, John J. Smith, of New York City, recently talked over the radio. His feat was made possible by the sonovox, an invention of Gilbert Wright, of Los Angeles, Calif. Wright's device produces a continuous buzzing in the throat of the user. When a mute's lips silently form the words he wishes to utter, the buzzing is changed into audible and understandable sounds. In this way, the California inventor's mechanism enables a mute to carry on a conversation.

# Hobbyhorsing with Sea Horses

MORE than 25 sea horses swim about in a two by three-foot aquarium in the home of Mrs. Ada Latham, at Philadelphia, Pa. Five years ago, Mrs. Latham started her hobby of raising these curious creatures when she captured several during a visit to Atlantic City, N. J. She is said to be the only person in the country who has succeeded in breeding sea horses in a home aquarium.

At spawning time, as many as eight or ten baby sea horses, hardly larger than mosquito larvæ, can be seen riding about in the aquarium attached by their tails to a swimming parent. They have hatched in a pouch on the male's body in which the female places her eggs.

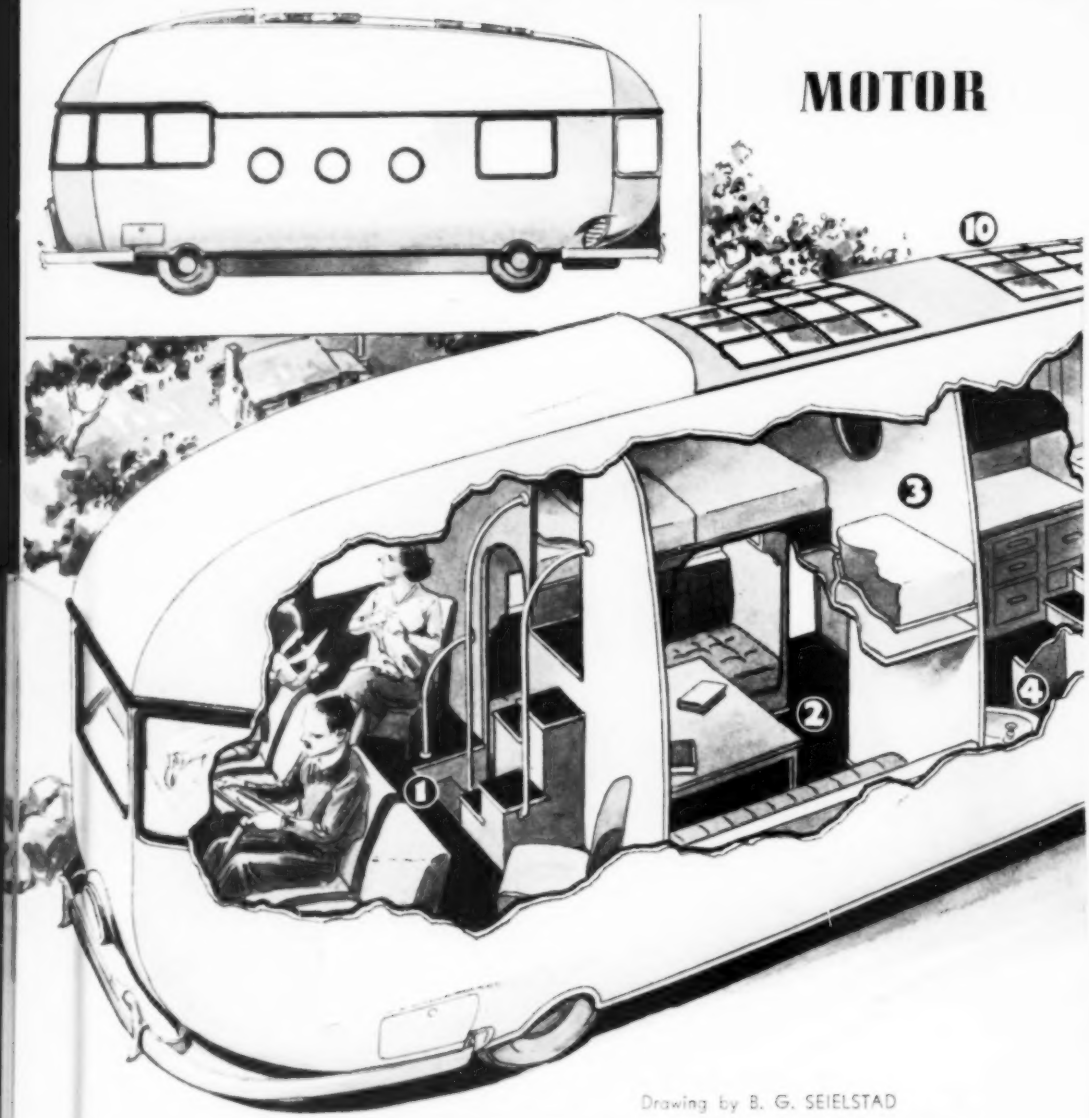
So far, Mrs. Latham has found that dwarf sea horses from Florida succeed best in breeding in captivity. In her small aquarium, some of the sea horses have lived as long as two and a half years.

Three real sea horses twining their tails around an imitation one in the aquarium of Mrs. Ada H. Latham

Sea-horse eggs. The female deposits them in a pouch of the male, where they hatch

Mrs. Latham, said to be the first American to succeed in breeding sea horses in a home aquarium

She feeds her pets microscopic brine shrimp, hatched from shrimp eggs which she gets from California in dried form as seen at left




Drawing by B. G. SEIELSTAD

1 Forward compartment seats driver and five passengers.

2 Seats in lounge become single berths at night.

3 Upper-deck cabin contains double bed and seat-berth with locker.

4 Lavatory, toilet, and shower. Unitary coupling for utilities.

5 Galley has range, sink, ice box, and cupboards.

6 Balcony leads to rear upper-deck cabin with double bed.

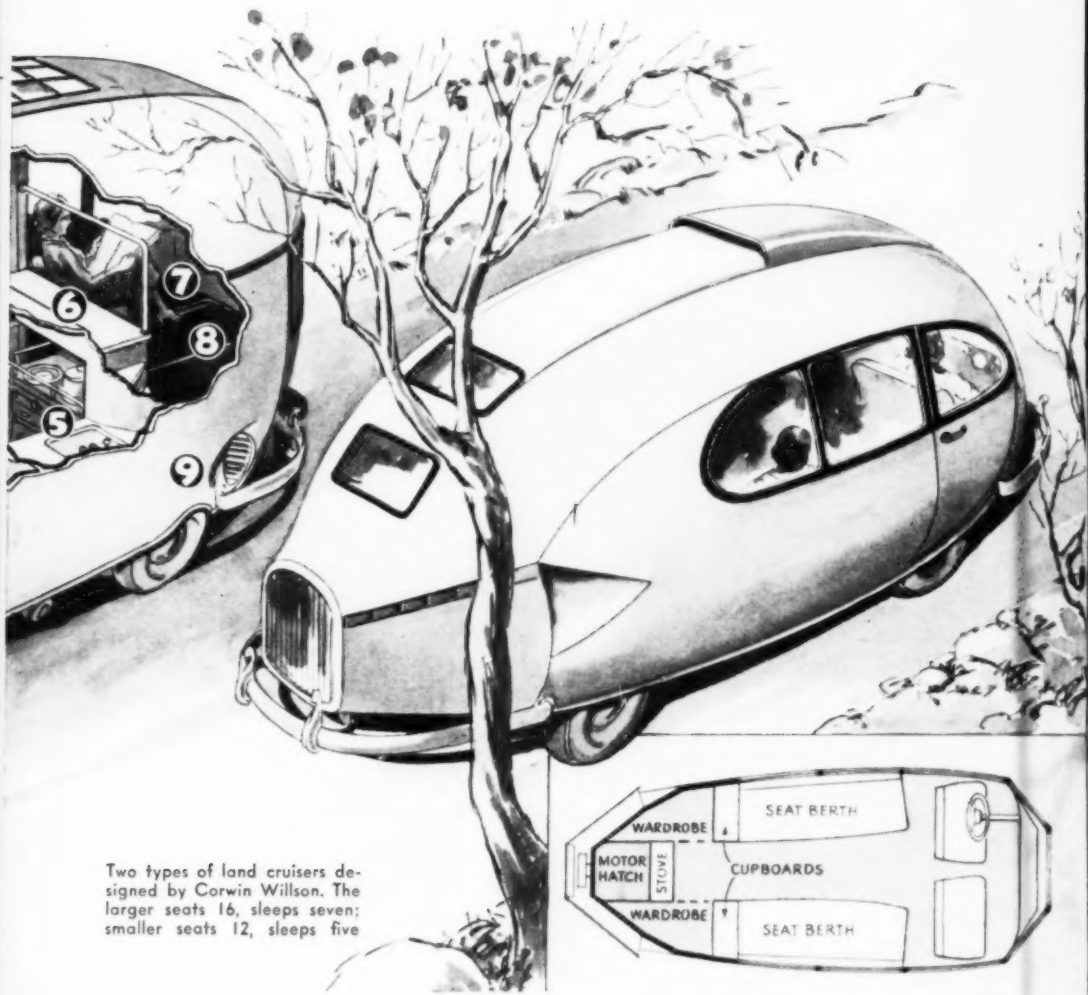
7 Rear-compartment "observation car" seats two.

8 Hatch gives access to engine under rear deck.

9 Scoop leads air to engine fan and radiator at rear.

10 Skylights admit light to upper-deck cabins.

# TRAILERS ARE HOMES ON WHEELS




Two types of land cruisers designed by Corwin Willson. The larger seats 16, sleeps seven; smaller seats 12, sleeps five

FOR TRAVELERS who like to satisfy their wanderlust by touring the highways in mobile houses, Corwin Willson, of Flint, Mich., has designed two types of land cruisers which combine the comforts of home with the mobility of a car and trailer. Both include shower baths, kitchens, and heating units. The smaller one, 17 feet from bumper to bumper, has a seating capacity of 12 persons, and bunks for five. The larger one will seat 16, or sleep seven. The extra space in the bigger model, labeled by Willson a "Duo-Deck Dynamic House," is provided by the addition of an upper floor, which raises the roof to almost 12 feet above the road level. Both models have engines mounted in the rear and a special wheel-suspension system designed to give maximum stability on the road. When the family is living in a stationary home, the mobile home can be parked beside it, to provide additional living space.

## Skiers Take Their Ease on New Cable Tramway

A CABLE system of new design, called the skimobile tramway, carries skiers up the mile-long slope of Mt. Cranmore at North Conway, N. H. Passengers ride on comfortable seats in an endless "train" of cars going up and down a pair of tracks, at a speed that may be varied from one to ten miles an hour. Wear on the towing cable has been minimized by having the individual cars support it, and angle-changing sheaves are used only on parts of the track at angles of fifteen degrees or more.

Above, air view of Mt. Cranmore, N. H. with cable tramway for skiers ascending its mile-long slope

Left, H. D. Gibson, skis at his side, starts up with a wave of the hand. A safety device stops cars in nine feet if the cable breaks

## Question Bee

For answers see page 218. You get ten points for each one you have right. A total score of 70 is good

1 A band saw is *(a)* a musical saw played in orchestras *(b)* a saw in the form of an endless ribbon *(c)* a two-handled saw.

2 When a number of duplicate pieces are to be made of wood or metal, a handy aid is a *(a)* shaper *(b)* jig *(c)* saw set.

3 Soldering is generally done with the aid of a *(a)* fixative *(b)* lubricant *(c)* flux *(d)* drying agent.

4 Garnet paper is useful for *(a)* making working drawings *(b)* wrapping tools to keep them from rusting *(c)* taking the place of sandpaper.

5 The operation called "turning" is done with a *(a)* circular saw *(b)* lathe *(c)* buffing wheel *(d)* reamer.

6 To thin shellac, you would use *(a)* alcohol *(b)* linseed oil *(c)* water.

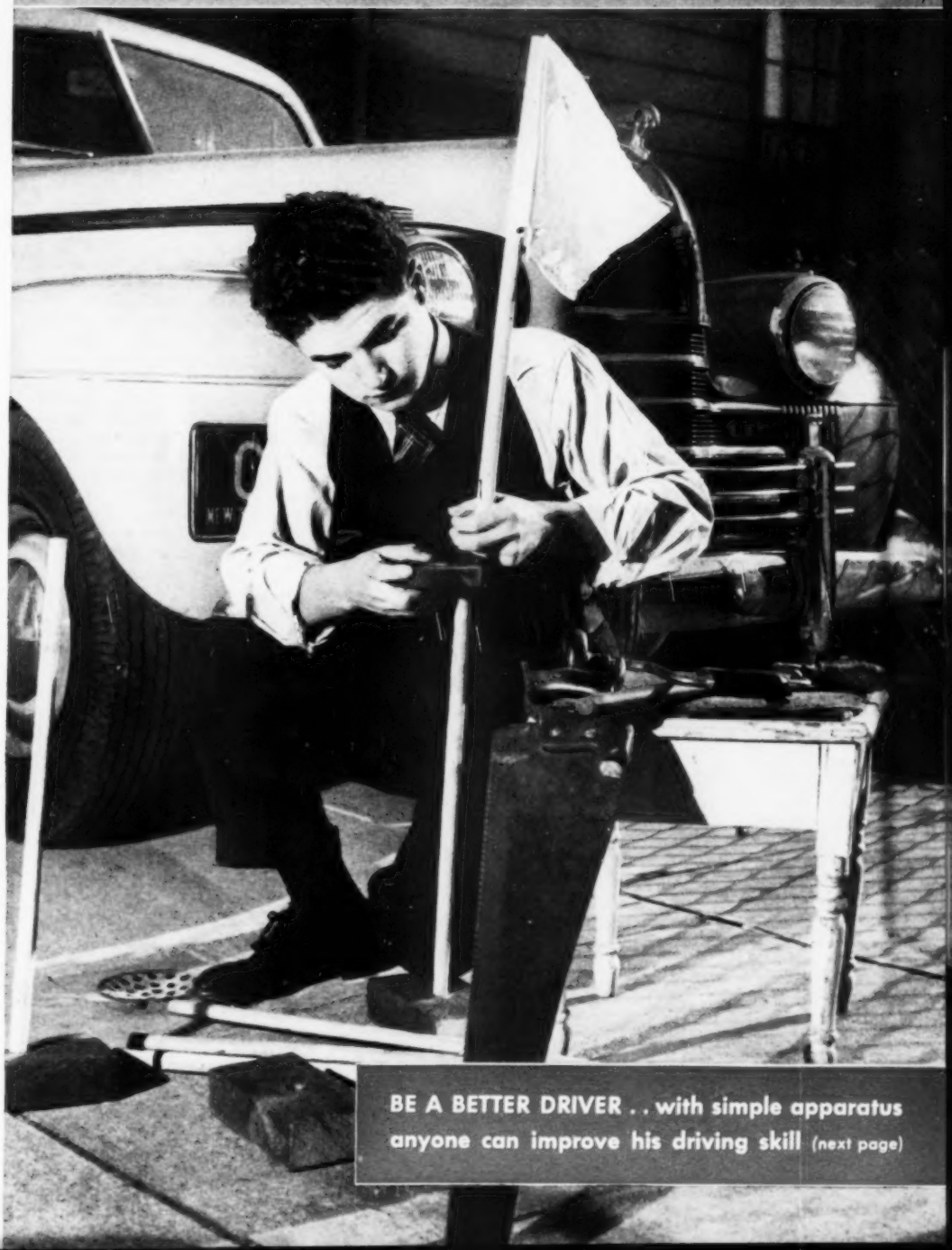
7 Plywood *(a)* comes from the plywood tree *(b)* is made by bonding pressed sawdust *(c)* consists of laminated wooden sheets.

8 A gouge resembles a chisel, except that *(a)* its cutting edge has many small teeth *(b)* it is always made of copper *(c)* its blade is curved instead of flat.

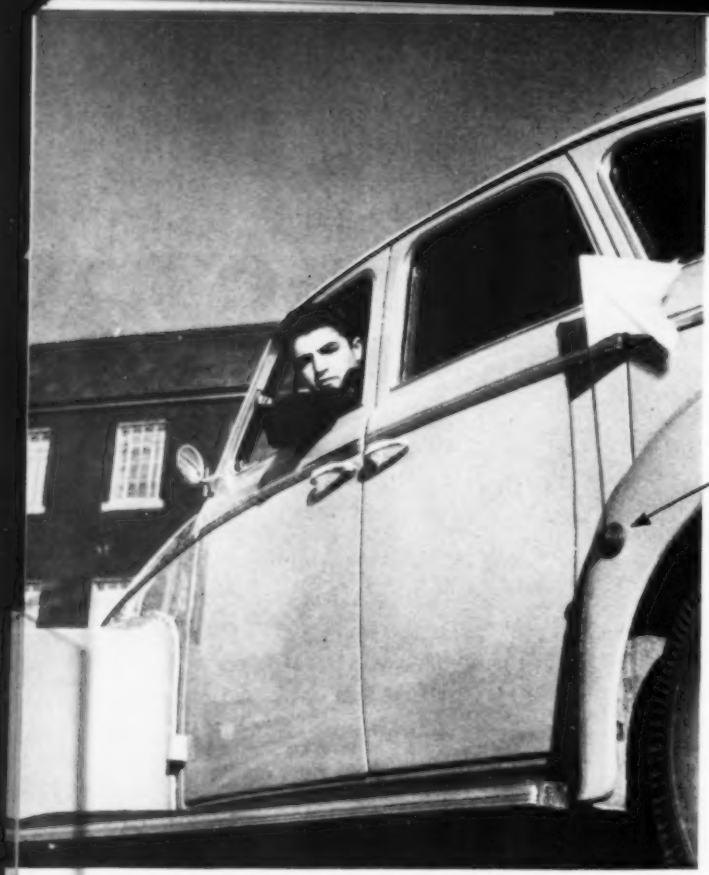
9 With a drill press, you can *(a)* straighten bent drills *(b)* bore holes in metal *(c)* print your own calling cards.

10 Objects can be attached to woodwork most securely with *(a)* nails *(b)* screws *(c)* glue.

# AUTOS



**BE A BETTER DRIVER . . with simple apparatus anyone can improve his driving skill** (next page)



To practice backing, sight over left fender at center line of road

This easily made flag, attached to the fender by a suction cup, will help you master backing technique

# How Experts Teach You To Handle Your Car

## By SCHUYLER VAN DUYNE

DO YOU drive nose first into a parking space at the curb? Do you open your car door and lean out to see where you are backing? Or work the steering wheel like a rowing machine when you turn a corner?

If you do these things, you probably aren't so hot a driver as you'd like to be. It may not be your fault, either, but the fault of the person who taught you to drive.

Unlearning bad habits is the answer, or, if you are just learning to drive, mastering good habits at once. To aid you, POPULAR SCIENCE asked Milton D. Kramer, in charge of the traffic center and driver safety program at New York University's Center for Safety Education, to outline a series of steps by which anyone can improve his driving technique.

He recommends first that you make yourself a set of simple markers out of wood dowels. You'll need four, set in blocks of wood, with pieces of cloth tacked to their tips. They should be about four feet tall. In addition, get an 18-inch length of stiff wire and attach one end to a rubber suction cup obtainable at the five-and-dime store, and tie another small square of white cloth to the other end.

This is all you need, except for a little-used street with a white traffic line down the middle. Fasten the suction-cup flag to your left rear fender as shown in one of the accompanying illustrations. Get in your car and set the left wheels on the white line. You are ready for Lesson No. 1: simply driving back and forth on the line.

If you're like many drivers, you probably oversteer while backing and understeer going forward. Another common backing mistake is opening the door and leaning out to see where you're going. Never do this; first because it's dangerous; second, because you cannot develop steering skill while some of your muscles are trying to keep a heavy door from swinging.

For proper backing, stick your head out of the window and look back. Here is where the fender flag is useful. Sighting over the top of it at the white line on the road behind your car, practice keeping your course with very slight movements of the wheel. This will prevent getting far off the line, and make it easier to get back.

Now go forward. Fix in your mind's eye

the direction your car must go to stay on the line. Stop and check your position on the line occasionally. Keep driving forward and back until you can stay on the line. It will take a lot of practice, but you'll wind up with a new sense of control over your car.

Do you know how to turn a corner, and that the proper way to make a right turn isn't the same as that for a left? For practicing right turns, set one of your flags exactly on the corner of an intersection. Approach the intersection in the right-hand lane and wait until your front wheels are opposite the flag before starting to turn. As in all forward driving, your hands should be placed at positions corresponding to 10 and 5 on a clock dial. Beginning the turn, move the wheel with both hands at first. As the left or 10-o'clock hand passes the center line of the wheel, bring the right hand up and over, grasping the wheel where the left hand was. Continue the turning motions by a hand-over-hand method as far as needed, then reverse the process to straighten out. Always hold the car speed down on a turn to the point where you can easily steer it around without going into the wrong side of the cross street.

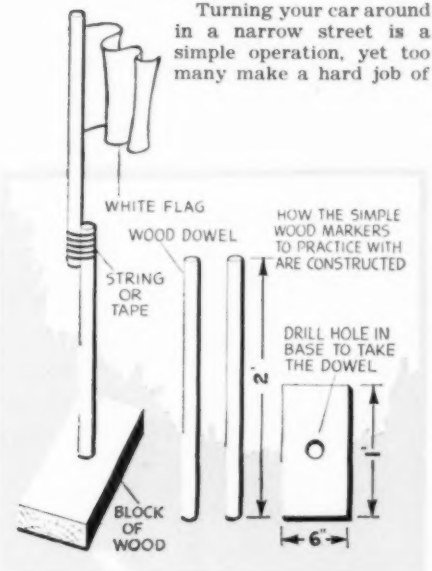
For proper left turns, you start turning sooner, just when the front wheels are opposite the cross walk. You'd be surprised how placing a marker right on the crosswalk will help. Your left-turn approach should be from near the center of the street. Again use the hand-over-hand method.

Turning your car around in a narrow street is a simple operation, yet too many make a hard job of it. Don't start the maneuver, for example, from the middle of a narrow road unless you like to waste elbow grease. Make sure no traffic is approaching from in front or behind. Then turn the wheel left rapidly. Hold it there until you are just short of the opposite curb, where you halt. Get in reverse and immediately start turning the wheel hand-over-hand as far right as it will go while you inch your car back. When the wheel is turned fully, let the car back faster and again stop just short of the curb. Start slowly forward again, once more reversing the wheel position.

That's all. You're around. You'll find few streets that require more jockeying than this. Yet repeatedly you'll see drivers jockey a half dozen times on such a maneuver. The secret of the simple turn lies in getting the shortest possible turning radius out of your front wheels on each stage of the job.

Practice of angle parking again calls for your four tall stanchions. Set them up to define the space between two imaginary cars parked diagonally at the curb. It's a good idea to tie light strings between each side pair to show you where the sides of the cars would be.

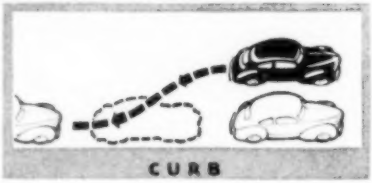
Now approach the standards slowly, driving along near the center of the street on a line about six feet out from the outer pair. Don't turn in until you know your rear wheels will clear the imaginary car at the right, but soon enough so that your front bumper will get by the car on the left. If it cannot be done, you were not far enough out as you approached. Practice will




## Driving Lessons Step by Step

*HERE'S a complete course in better driving, as outlined by experienced teachers. The various steps should be mastered in order as given.*

1. Adjust driver's seat for yourself.
2. Learn the purpose of all controls.
3. Learn to start motor.
4. Starting and stopping—low gear.
5. Shifting to second and stopping.
6. Shifting to high and stopping.
7. Shifting from high to second, low.
8. Backing.
9. Driving on a painted line.
10. Right turns.
11. Left turns.
12. Turning car around.
13. Angle parking.
14. Parking in space at curb.
15. Starting and parking on a grade.
16. Open-highway driving.
17. City-traffic driving.




With four flag stanchions and a little-used street, you can learn to back a car neatly into a narrow space at the curb, as illustrated in the diagram at the right

master its tricks, too. It is the apparently simple job of getting into a narrow space between two cars parked flat against the curb.

Let the standards again represent the space where you wish to squeeze your car in; say, 25 feet to start with. You can dive into this with your front wheels, but they'll have to come out again before you'll ever get your rear wheels in too. So why not do it the right way? Here it is:

Drive up close beside the forward imaginary car so that your rear bumper is exactly opposite its rear bumper—in this case the forward pair of standards. Turn your steering wheel sharp right. Back up until the flag at the curb behind you is directly in the center of your rear-view mirror as you sit normally at the wheel. Instantly straighten the wheels. Back until the right tip of your front bumper is just past the left tip of the rear bumper of the car ahead. Cut your steering wheel sharp left, and continue back again until the front of your car is close to the curb. Straighten your front wheels and center your car in the space.

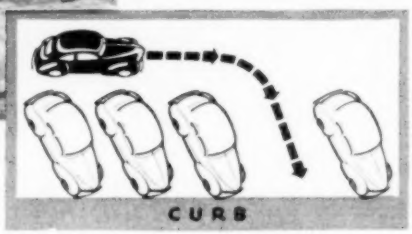
It sounds hard to do. But you'll find it's easy when you know how.

show how far out in the street this should be for the car you are driving, and also how far out for the width of the parking space that is available. This type of parking must be mastered if you would avoid fender damage to your own and other people's cars.

There is still another parking maneuver that even drivers of long experience stumble over, and your standards will help you

Kramer points out that the University's driving course is considerably longer than this, but that mastery of these maneuvers is of utmost importance to the making of a skillful driver. Furthermore, no matter how long you've been driving, if there is room for improvement, it's likely to be in one of these departments.

In addition, he cautions



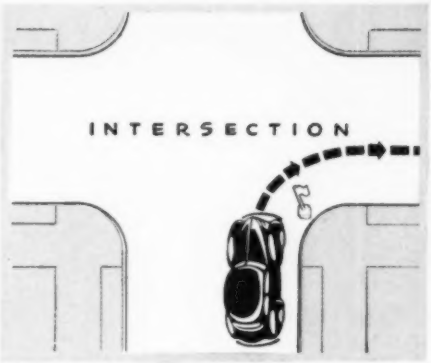

Angle parking, too, is an art. The secret is to approach from far enough out in the street, and to cut your wheels at just the right time to clear the cars on either side of the space

beginners as well as those driving new cars to familiarize themselves thoroughly with the driving controls and mechanism before setting out for the first time. Learn to depress your clutch before starting your engine, to lighten the load on the starter and battery. Know your driving hand signals and traffic regulations. Get so that you can perform all driving motions without looking at your hands and feet before you even start your motor for the first time.

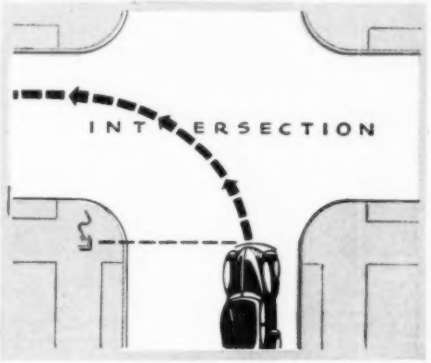
At this point the beginner should master the art of starting in low gear and stopping again, thus avoiding the common mistake of getting directly into high before he is ready. He should start and stop many times—always using low—before going on to second, where he should return to a stop again many more times before trying out third gear. When he can shift with skill from low to second to high and stop, then he should learn to go back down the scale—or from high to second to low and stop. If the practice street is short, his instructor should do any necessary turning around of the car while the student watches closely so that he will be better able to make the maneuver himself when the time comes.

The next seven lessons already have been described, and the entire series is enumerated on page 135. Under the carefully worked-out program, each lesson prepares you for the next, and experience has proved that leaving out or skipping rapidly over any of them makes a big difference in the ultimate driving skill of the beginner.

Above all, learn to drive with a competent instructor, and just because you eventually get your license, don't think you are all set for the races. The drivers with the best traffic records are the race drivers themselves, who always drive on the highways with top skill and caution.

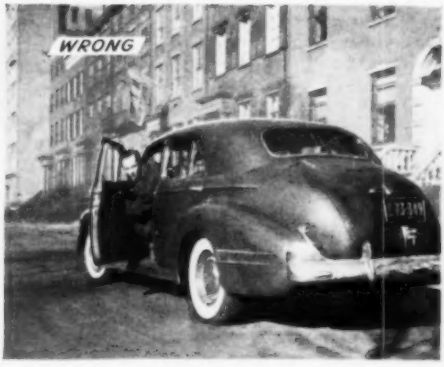



In making a right turn at an intersection, stay well over to the right. When your front wheels are even with the corner, cut close to the curb




For a left turn, start turning sooner—when your front wheels are even with the cross walk. Swing wide, passing near center of intersection

## A Tip on Backing: Don't Open the Car Door and Lean Out



# Spark Tester

Ernest R. Becker, spark-tester at the Buick metallurgical laboratories, trying out a sample of steel

FLYING sparks, made by holding a piece of steel against a high-speed grinding wheel, now safeguard the quality of the many kinds of steel used in motor cars. Working in a darkened laboratory, expert metallurgists of the Buick inspection department observe the shape and brilliance of the incandescent particles. By this speedy and simple test they find out just what ingredients the steel contains—and how much of each.

Even an untrained eye, they point out, can distinguish widely different types of steel by the spark test. Luminous particles from low-carbon steel are spikelike and contain few forks. As the carbon content increases, so does the branching intricacy of the spark pattern. High-carbon steel yields a beautiful "bushy" display, in which bursting sparks scatter particles that explode again, like Fourth-of-July skyrockets.

A skilled operator using the same test will accurately estimate the amount of carbon in the steel, up to 30 percent, within two one-hundredths of one percent. He also recognizes the characteristic sparks of such alloy ingredients as manganese, chromium, molybdenum, silicon, nickel, and tungsten. Manganese steel, for example, gives sparks of high temperature and great brilliance, while sparks from chromium are less bright near the wheel and the stream is thinner. The amounts of these materials, too, are revealed by the spark test. When a metallurgist must differentiate two complex alloys of very nearly the same composition, which is the most difficult of his jobs, he uses standard bars of known make-up for comparison.

In the Buick laboratory, spark testing serves three important purposes. It tells in a moment whether a delivery of raw material conforms to the car manufacturer's rigid specifications. It guards quality during manufacture—not replacing, but supplementing chemical analysis. Finally, it bars any possible mix-up through which a wrong kind of steel, outwardly indistinguishable from the right one, might be used in producing a part. The spark test shows in a jiffy whether the metal is kingbolt stock, steel for transmission gears, or

This is the spark stream from a piece of low-carbon steel rated 1010 by the standard of the Society of Automotive Engineers, with a carbon content of .05 to .15 percent. The stream is thin, with few bursts

As the carbon content increases, the spark stream thickens and bursting particles form forklike patterns. This is S.A.E. 1050, .45 to .55 percent carbon. Expert testers rate samples within .02 percent

Be a spark-tester! Read the second paragraph of this article again, look at the pictures above for comparison, and tell what kind of steel made the sparks shown below. The answer is at bottom of next page

Charles Flewelling, one of Buick's ace spark-testers, uses a hand grinder for checking a batch of material in the engine plant, to make sure of quality and to guard against a mix-up in stock

high-carbon steel used for spring clips and washers.

Take kingbolts, upon which hinge the front wheels of your car—and your life. Since they must not break, they demand a soft but tough core, devoid of any high-carbon steel. To make sure that none is present, the spark test is applied to 100 percent of kingbolt stock. Transmission-gear steel likewise is all spark-tested, while a percentage of samples suffices for tests of torque tubes, washers, and rivets.

Spark testing is an art, and its accuracy depends upon the skill of the observer. The selection of the wheel, the speed of its revolution, and the amount of pressure in making contact all play a part in producing a spark stream that is easy to interpret.

Sparks from the grinding wheel actually are small chips of the metal, flying off at a temperature high enough to make them glow. According to one theory, sudden escape of a gaseous oxide of carbon from within a molten globule causes its explosion and scatters smaller particles. At any rate, carbon seems to be necessary for producing "bursts" of sparks, which rarely occur with pure iron.

Some soft, nonferrous metals, including copper and aluminum, do not spark at all in air. For this reason, certain copper alloys are employed in making tools for use in powder plants and other factories where there is an explosion hazard.

*(The spark stream shown in the picture at bottom of the preceding page was made with high-carbon steel, rated 1070 in the S.A.E. scale, with .65 to .75 percent carbon. Note the "bushy" appearance of the display and the skyrocket effects produced by repeated explosions of particles.)*

## Light Beams from Tester Show Wheel Alignment at a Glance

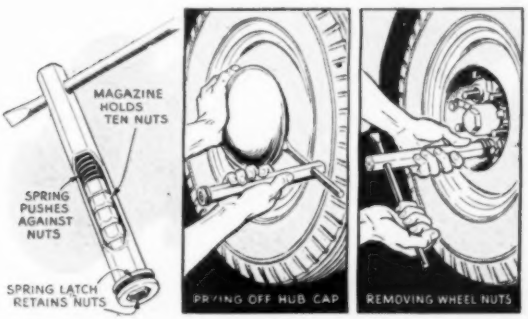
Lenses on the apparatus flash light beams on a calibrated chart

WHEEL alignment, important to steering ease and the life of the tires, gets a thorough check in a testing device recently exhibited at Chicago. Wear on the suspension parts at the front end of a car is also plainly revealed. Light beams from three lenses flash front, side, and rear measurements on a screen visible both to a garage mechanic and his customer. Thus a car owner may see for himself when repairs or adjustments are required, and will understand what he is paying for when he gets his bill.

## Portable Trap for Speeders Clocks Them Electrically

THERE'S no use arguing with the motor-cycle cop if you run afoul of an electric speed trap introduced by traffic engineers of Detroit, Mich. Twelve feet apart, a pair of wires cross a highway lane. As a car passes over each wire in turn, an electric mechanism automatically measures the time interval, and registers the car's speed in miles per hour. Inexpensive and portable, the devices can readily be set up at intersections or school approaches.

Light in weight, the speed checker can be quickly set up where desired



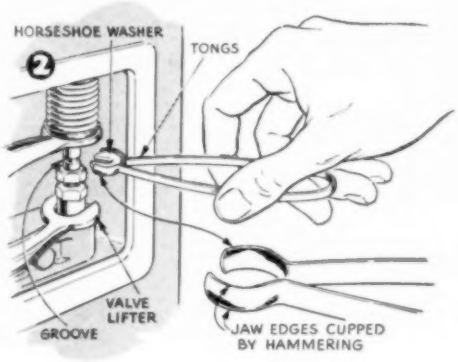

## Hollow Tire Wrench Holds Wheel Nuts

WHEN a motorist has a flat, a "magazine wrench" makes quick and clean work of changing a wheel. A screw-driver tip pries off the hub cap without marring it. Then the wheel nuts, as fast as removed, pop into a magazine in the hollow tool. Fed back in attaching a spare wheel, they automatically are released from the magazine as they are tightened, one by one.

# HELPS FOR MOTORISTS

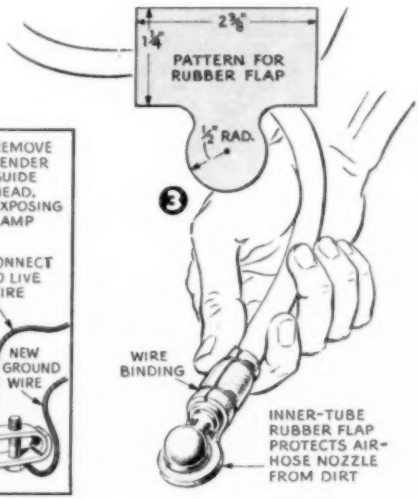
**1 LUBRICATING DOOR LOCKS** with a little finely flaked graphite is one of the most effective ways of keeping them from sticking. To get the material into the keyhole, dip an ordinary soda straw into the supply of graphite, then pinch the end so the straw will fit into the keyhole. Blowing into the other end will force the material into the lock of your car door, a little of it getting into every corner of the lock for a perfect job of lubrication.—A.H.W.

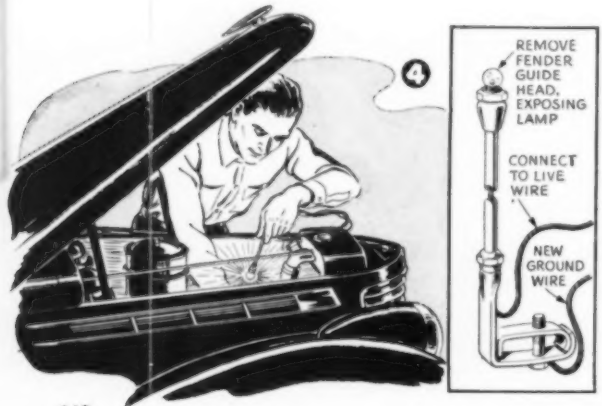
**2 A SIMPLE HOLDER** for installing horseshoe washers on valve stems and other spring-tension units can be made from a 14" strip of sheet metal about ¼" wide. Shaped like sugar tongs, and with the ends cupped as shown, the holder easily grasps the washer for setting in place, without any danger to the worker's hand should the valve lifter fail during the job.—N.W.



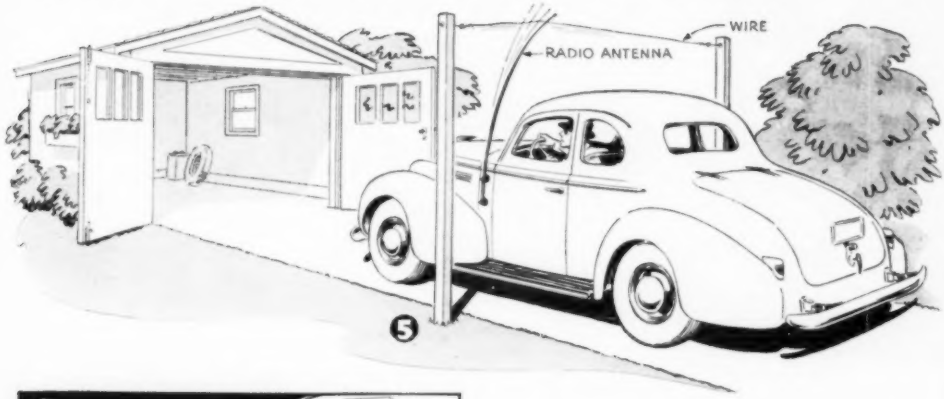

**3 DUST WILL NOT COLLECT** in the nozzle of the service-station air-hose adapter if a flap made of inner-tube rubber is wired securely in place as indicated in the drawing. Taking but a few minutes to make, the attachment will prevent dirt from entering valves while tires are being pumped up. The flap bends back easily on contact with the side of the tire valve stem.—O.R.

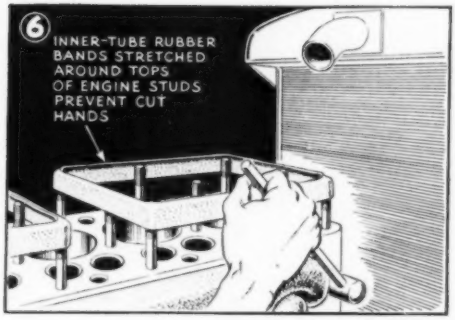
**4 WITH A TROUBLE LAMP** made from an old illuminated fender guide, you always have power on tap for night repair jobs. Jaw-type terminals on the wires shown in the diagram will facilitate connecting the unit to your car's electric system. Remove the translucent globe from the lamp for better light.—D.L.G.

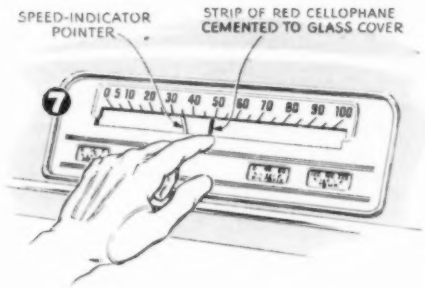


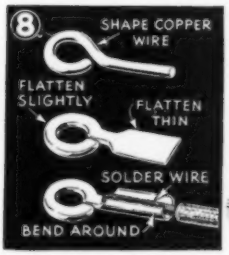



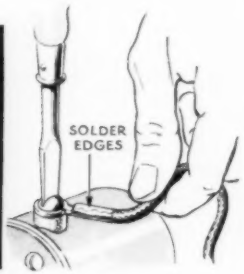
# AND SERVICE MEN




**5 FISHPOLE ANTENNAS**, often raised above the level of your garage doorway, may get broken against the door frame or the ceiling of the garage if not lowered before driving your car in. A wire stretched over the driveway between two posts of required height will strike the antenna if too high, setting the antenna swinging as a warning to lower it to safety.—L.D.

**6 RUBBER BANDS** cut from an old inner tube and stretched around the engine studs while the head is removed for work will protect the hands and fingers from scratches and cuts against the sharp stud threads. Make the bands wide enough to cover the threads and curve over the ends of the studs.—H.A.

**7 A RED CELLOPHANE STRIP** cut from the tab of a cigarette package can be made into an effective warning marker for your speedometer. Cement a short piece of it on the glass over the numerals representing the maximum speed limit of your community. A glance at your speedometer pointer while driving will always show whether you are staying safely below the limit.—P.J.F.

**8 HOMEMADE WIRE TERMINALS** can be turned out in a jiffy with only a hammer and a soldering iron. Using short pieces of stiff copper wire, bend them and pound them flat as shown in the drawing, and solder the wire leads for a permanent contact. The terminals thus formed make handy connectors for many car accessories such as cigarette lighters, fans, turn signals, etc.—C.W.S.

"I'll be eternally gad-busted if I like anything about this place," Barnstable squeaked

# GUS almost muffs one

By MARTIN BUNN

"HEY!"

Gus Wilson looked around from the workbench in his Model Garage shop and saw Silas Barnstable standing behind him, the light of conflict in his faded blue eyes and his whole five feet four inches of skinny frame bristling truculence.

"Hey yourself," Gus said mildly. "And how do you like it?"

"I'll be eternally gad-busted if I like anything about this place!" Barnstable squeaked. "Just because I've been foresighted enough to lay by a few dollars don't mean I'm one of these millionaires who *like* to get skinned. I—"

Old Silas has been sitting pretty ever since he sold his farm to a building speculator back in the boom days of the Easy-Money-Twenties, but he's a tight old cuss, and he puts up a roar about his Model Garage account regularly each month. "You'd better go in and talk to Joe Clark," Gus suggested pleasantly. "He makes out the bills, you know."

"It ain't a bill I'm kickin' about this time," Silas told him, "although your bills always are 'way too high. But what I say is, when you charge a man for a job, why don't you do the job right?"

"We aim to do all our jobs right," Gus said. "But we're human, and so once in a while we don't hit the bull's-eye—and you know mighty well that when we miss we always make good. Just what's biting you, anyhow?"

Silas produced a pipe from his pocket and went through the motions of searching for his tobacco pouch. "Gimme a fill, will you, Gus?" he asked. "I must have gone and left my tobacco home."

Silas never has any tobacco on him—not when he thinks there's a chance of cadging a pipeful from some one. Gus grinned and handed over his can of "Delight." The old fellow loaded the bowl of his briar, tamping the tobacco down hard with his bony fingers to get as much in as he could. Then he borrowed a match and fired up. "You know how I am," he said after he had

taken a few puffs. "When I don't get what I pay for I raise the devil!"

"I've noticed that," Gus admitted. "I've also noticed that you usually raise the devil even when you do get what you pay for. Well, what is it now that you think you've paid for and haven't got?"

"Yesterday," Silas explained, "I brought my car in here because the last couple of weeks the motor's been missin' every time I drove over 35 miles an hour. You wasn't here—gallivantin' around downtown somewheres, I suppose. So I told that new mechanic of yours about it. He run up half an hour time on me foolin' with the motor, and then he says the car's all right—just needed a little tightenin' up. But it *ain't* all right. Soon as I get out on the open road and speed up to 35 she starts missin' again. So now, by heck and by gosh, I want . . ."

"All right, all right!" Gus said. "You'll get what you want if it's coming to you." He raised his voice. "Bill, what work did you do on Mr. Barnstable's car yesterday?"

Bill, the new mechanic, stuck his head out from under the bus he was busy on. "Checked the plugs, distributor, condenser, points, carburetor, and ground strap," he reported. "Tightened up a few connections. Then I tested her out, and there wasn't any miss."

"Road test?" Gus queried.

"Nope," Bill said. "I didn't see any need for one. Engine didn't miss when I speeded her way up."

"I'll have a look," Gus told Silas, and led the way out to where the car was parked. He got in and stepped on the starter, then raced the engine. It ran smoothly and evenly. "Hop in," he said to Silas. "We'll go for a little ride."

He drove slowly for a few blocks. The engine still ran smoothly. Then, at the foot of a long and fairly steep grade, he pressed down on the accelerator pedal and watched the speedometer hand. When it got to "35" the engine seemed to miss.

Gus slowed down to 30, and the miss disappeared. He speeded up, and the engine lagged again. And now he noticed something else. "You've got a bad case of shimmy," he told Silas.

"You mean that bouncin' around like, up front?" Silas asked. "That don't do me any hurt—I ain't a scorcher."

"You ought to have it fixed up," Gus persisted. "You don't have to be a 'scorcher' to be inconvenienced by hard steering and to be put out of pocket by the excessive tire wear caused by a bad shimmy. Well, you're right for once—your engine misses at 35. Let's go back to the shop and see what's the matter with it."

Back in the shop Gus went over wiring, carburetor, and ignition without finding anything wrong. "That shimmy has something to do with the engine missing," he decided. "Let's see now—"

It took him 15 minutes of careful checking to locate any trouble. The inside ear of the exhaust-manifold flange, which couples to the exhaust pipe, was badly cracked.

Bill scratched his head. "Now what do you think of that!" he exclaimed. "I should have found it, but I didn't. But why the dickens does that make the engine miss?"

"I haven't said it did," Gus replied to his helper. "In fact, I don't think that motor's missing at all."

Bill looked puzzled. "But you tested it . . ."

"All right, I tested it. And I was wrong about the miss," Gus admitted. "Look, here's what happens: That car runs fine up to 35 when two things suddenly go wrong. First, the wheels start to shimmy. Second, the engine speed is just right to shake the motor at the right speed to start the exhaust pipe swinging so that a real crack opens up periodically in that broken flange. That lets some exhaust gas pop out.

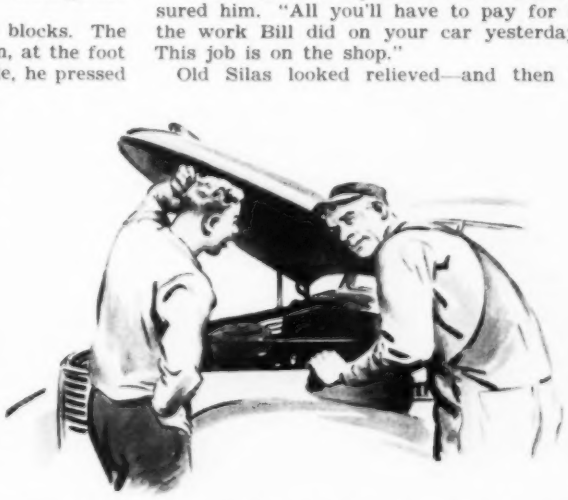
"The shimmy tends to slow the car. The popping sounds like a miss. The effect on your ears and other senses is just like that from a missing motor. See?"

Bill, astonished, admitted that he saw.

"Hey!" Barnstable snapped. "That's goin' to be an expensive job, ain't it?"

"You needn't worry about that," Gus assured him. "All you'll have to pay for is the work Bill did on your car yesterday. This job is on the shop."

Old Silas looked relieved—and then a



"But why the dickens does that make the engine miss?" Bill asked

crafty look crept into his face. "I call that fair, Gus—downright fair!" he said. "And while you're at it, you'll fix up that shimmy, of course—without chargin' me anything extra for it."

"We will—NOT!" Gus said. "If you want that shimmy fixed you'll have to pay for it."

Barnstable hesitated a long moment. "What'll it cost?" he asked at last.

"Depends on what's the matter," Gus said. "But whatever it costs, it'll be less than wearing out your tires and shaking your car to pieces costs."

"Well, you might as well do it, I suppose," the old fellow said. "But just you remember that I'm a danged good customer of this garage, and that I'm dependin' on you to do the fair thing by me!"

"O.K.," Gus said. "We'll have your bus fixed and ready for you by noon tomorrow."

## GUS SAYS:

**Ever see a car made? Well, I have. One thing that impressed me was the number of parts that *don't* get into your car. Inspectors all along the line eagle-eye the materials, and do they like to toss things into the ash can! Just one more reason why cars are so good these days!**

Bill looked downright embarrassed when Silas Barnstable had gone on his way. "I guess you're thinking I muffed that chance pretty badly," he said to Gus.

Gus grinned consolingly. "I muffed it a bit myself. If I'd just stepped on the gas harder when I thought that car began to miss, I'd have seen where I was wrong at once. Don't let a little thing like that worry you—you're catching on fine. Always worked in a big shop before this, didn't you?"

Bill nodded. "My job was on engines," he explained, "and I always had to stick right to my job. Never had much of a chance to learn anything else. Even if I'd road-tested old Barnstable's car I doubt if I'd have clicked on the idea that just a case of shimmy would make his car seem to lose power."

Gus lighted his pipe. "Shimmy'll do quite a few things to a car," he said. "Tell you what—let's both work on this job of chasing the shimmy out of Silas's wheels. That'll give you a chance to get a line on that sort of work. After we've finished that, you can go ahead by yourself on brazing that manifold ear."

"Swell!" Bill agreed. "But, say—before we start. I know what shimmy is, of course, but what causes it, anyway? And just what does it do to a car?"

Gus tipped his long-peaked cap over his left eye and scratched his right ear. "What's the cause of shimmy—? Say, Bill, that's sort of a big order! There are several kinds of shimmy, but the immediate cause of them all is the same—vibration of the front wheels from side to side or up and down. You always can spot it by a jerky motion of the steering wheel. Now let's—"

"Hey, wait a minute!" Bill said. "What are these different kinds of shimmy you're talking about?"

"What is this—a lecture?" Gus demanded. "Well, there's what they call critical-speed shimmy—it's caused by some part of the steering system vibrating in harmony with some other part of the car, often the engine. That's a mean little devil to chase, but the vibration isn't bad, and it doesn't do any real harm. Then there's low-speed shimmy—it disappears when you speed up over 30. Sagging springs or something loose in the steering system are the most common causes of that variety.

"And then there's high-speed shimmy—the kind you get at 35 or over. A lot of things can cause it. Loose wheels or loose steering connections, too much or too little toe-in of the wheels, broken or even weak leaves in the front springs, and shock absorbers that aren't doing their job right are some of them. But I've found that the front tires are the most likely cause—tires which aren't inflated enough or are inflated unequally, or which throw the front wheels out of balance. So let's have a look at Silas's front tires."

Bill jacked up the front end of the car. Gus began turning one of the wheels—and started to laugh before he had completed the first turn. Silas Barnstable is no part of a spendthrift, and he never lets a tire go until he has squeezed his full money's worth and a little more of service out of it. Gus pointed to two large vulcanized patches, about six inches apart.

"That one was a push-over," he said. "No use of us looking any further—there's the cause of this shimmy. I'll bet that each of those patches weighs a couple of ounces."

Bill examined the patches and shook his head doubtfully. "You're right, I suppose," he said, "but I'm darned if I can see how a couple of tire patches can set up enough vibration to do any real harm."

"They can cause shimmy, and wear out your tires, and shake the daylights out of your car," Gus insisted. "Im not much of a one for triple-jointed words, but it's a matter of centrifugal *(Continued on page 218)*

# Auto Ideas

## Running Down Noises in Cars

FINDING THE SOURCE of noise in a car is the purpose of the supersensitive sound detector shown below, being used by a Ford Motor Company engineer. Touched against a noisy metal part, it picks up and measures vibration velocity, thus helping locate the mechanical part causing the noise.

This "sound detective" finds causes of vibrations

No tools are needed to put this light on your auto

The ring is a vacuum cup, which holds lamp in place

## Spotlight Attached by Suction

NO HOLES need be drilled, and no tools are needed, for attaching a new automobile spotlight. Instead, a suction cup is permanently fastened to a convenient spot on the windshield, and the lamp housing is attached to this. It is adjustable by hand for various angles and can be removed to serve as an emergency light for nighttime repairs. A special switch gives steady light by turning, and intermittent light when pushed.

## Driving Mittens Glow To Aid Hand Signals

DRIVING MITTENS with their backs chemically treated to glow in the dark have been introduced for motorists. Besides being useful for giving hand signals to following drivers, the mittens provide enough light to show up the keyhole in a car or garage door. Exposed to a strong light momentarily, they are said to show the ground for several yards around, and still give off light after two or three hours. They are available in several sizes.

Besides helping to guide the following driver, as shown, glowing gloves emit enough light to locate a keyhole in a garage door

## Horn Toots Your Own Tunes

MELODY-MINDED motorists can make up their own tunes or play familiar bars with a new three-note horn set recently introduced. Easily mounted under the hood of your car and connected to a three-button keyboard that clamps on the steering column, the music maker plays single notes, or two or three at once. Sheet music is provided for those who wish to extend their repertory.

Every motorist is his own composer with this horn. Keyboard is at left

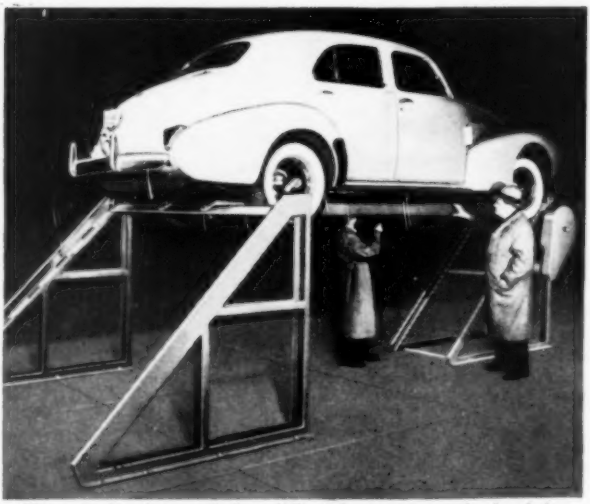
## Powerful Fender Spreader Aid to Repair Men

A POWERFUL fender spreader for automobile-body repair men is designed for attaching to all hydraulic jacks having $1\frac{1}{4}$-inch pipe fittings. Adaptable for close work where wide spreading is necessary, the jaws have a minimum clearance of $1\frac{3}{4}$ inch and a maximum spread of $19\frac{3}{4}$ inches. The travel of the hydraulic ram that powers the spreader is 6 inches. The unit is particularly useful for spreading between a car fender and fender well.

A new fender spreader attaches to a hydraulic body jack, opens to $19\frac{3}{4}$ inches and closes to $1\frac{3}{4}$ inch

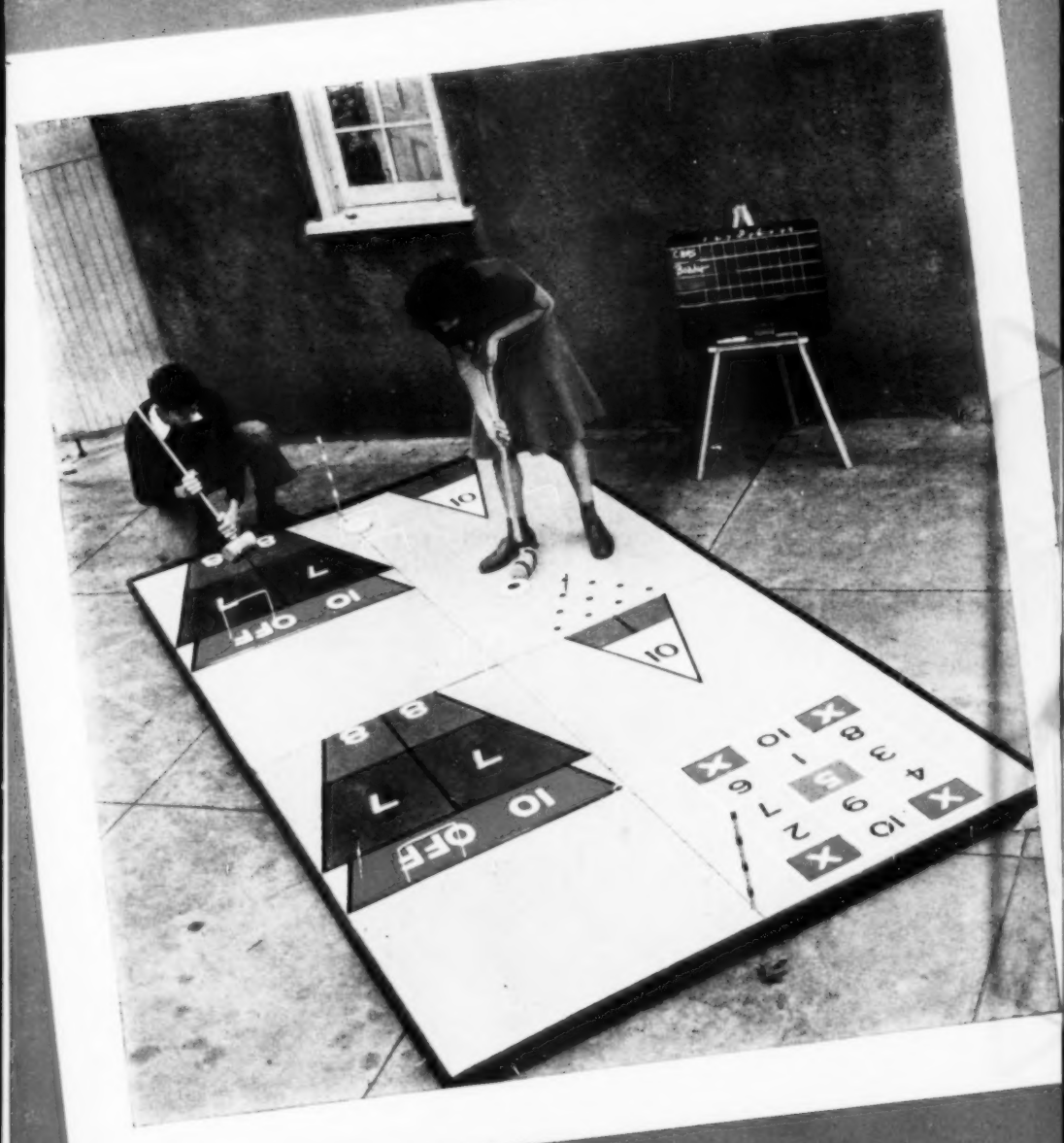
## New Lift for Cars Uses Principle of the Inclined Plane

BUILT on the principle of the inclined plane—an idea as old as the pyramids but entirely new in auto hoists—a new lift differs radically from the conventional hydraulic-piston lift as well as from other types. It actually rolls the load uphill to a convenient working height, keeping the car level at all times. Power required for its operation may be furnished by hand or by an electric motor, while installation requires no trench digging or underground equipment.



This auto has been rolled up hill, while staying on the level, by means of the two inclined planes, one at either end of the lift

# HOME and WORKSHOP




Novel Combination GAME COURT

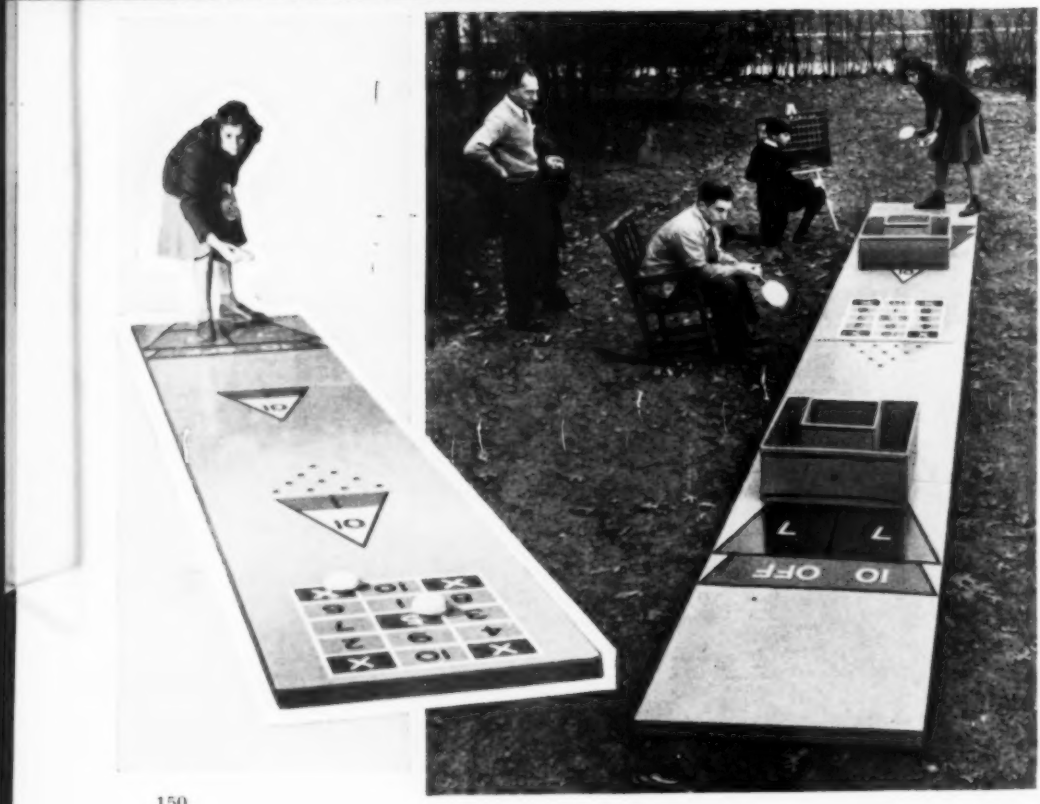
Next Page

# Fun-for-All Game Court

**DESIGNED ESPECIALLY FOR POPULAR SCIENCE**

**By**

**CHARLES and BERTRAM BROWNOLD**



EIGHT different games—active, competitive games—can be played on this portable court or giant game board. Its novelty alone is sufficient to make it the center of attraction at any party, and its uses are so many and varied that it won't lie idle for a minute so long as there is anyone around to play with it.

The court is made in four sections, each 3′ by 6′. When these are laid end to end, they form a shuffleboard court, as illustrated at the upper left of the facing page. This same arrangement is also used for a tenpin alley. If they are placed so as to form a 6′ by 12′ rectangle and are fitted with wickets and stakes, disk croquet can be played, as shown in the photograph on page 149. Other setups serve for the remaining games—bounce, darts, bullboard, twelve-hole, and quoits. While only eight games have so far been arranged on the court, many more could be worked out. The possibilities and combinations are almost endless.

The fact that the court is portable permits it to be used outdoors in fine weather and indoors, if space is available, at other times. In addition to being great fun at home, it is an ideal outfit for camps, play groups, resort hotels, recreation centers, and country clubs.

When the game court is to be stored or transported, all the equipment can be packed between the sections, for each section is really a shallow box. Two of the sections are used as boxes and two of them as lids. When filled, each pair of sections is held together by means of boards bolted on the ends with sixteen toggle bolts, as shown in one of the photographs on a following page.

Each section is constructed of a 3′ by 6′ piece of ¾″ thick five-ply veneer (plywood). This is a stock size, so

**EQUIPMENT FOR EIGHT GAMES**

| GAMES | Cues | Disks | Tenpins | Folding boxes | Table-tennis balls | Table-tennis paddles | Darts | Wickets | Mallets | Stakes | Bags of sand | Balls | Twelve-hole board | Quoits | Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shuffleboard | √ | √ | | | | | | | | | | | | | |
| Tenpins | √ | √ | √ | | | | | | | | | √ | | | |
| Bounce | | | | √ | √ | √ | | | | | | | | | |
| Darts | | | | | | | √ | | | | | | | | √ |
| Disk croquet | | √ | | | | | | √ | √ | √ | | | | | |
| Bullboard | | | | | | | | | | | √ | | | | |
| Twelve-hole | | | | | | | | | | | | √ | √ | | |
| Quoits | | | | | | | | | | √ | | | | √ | |

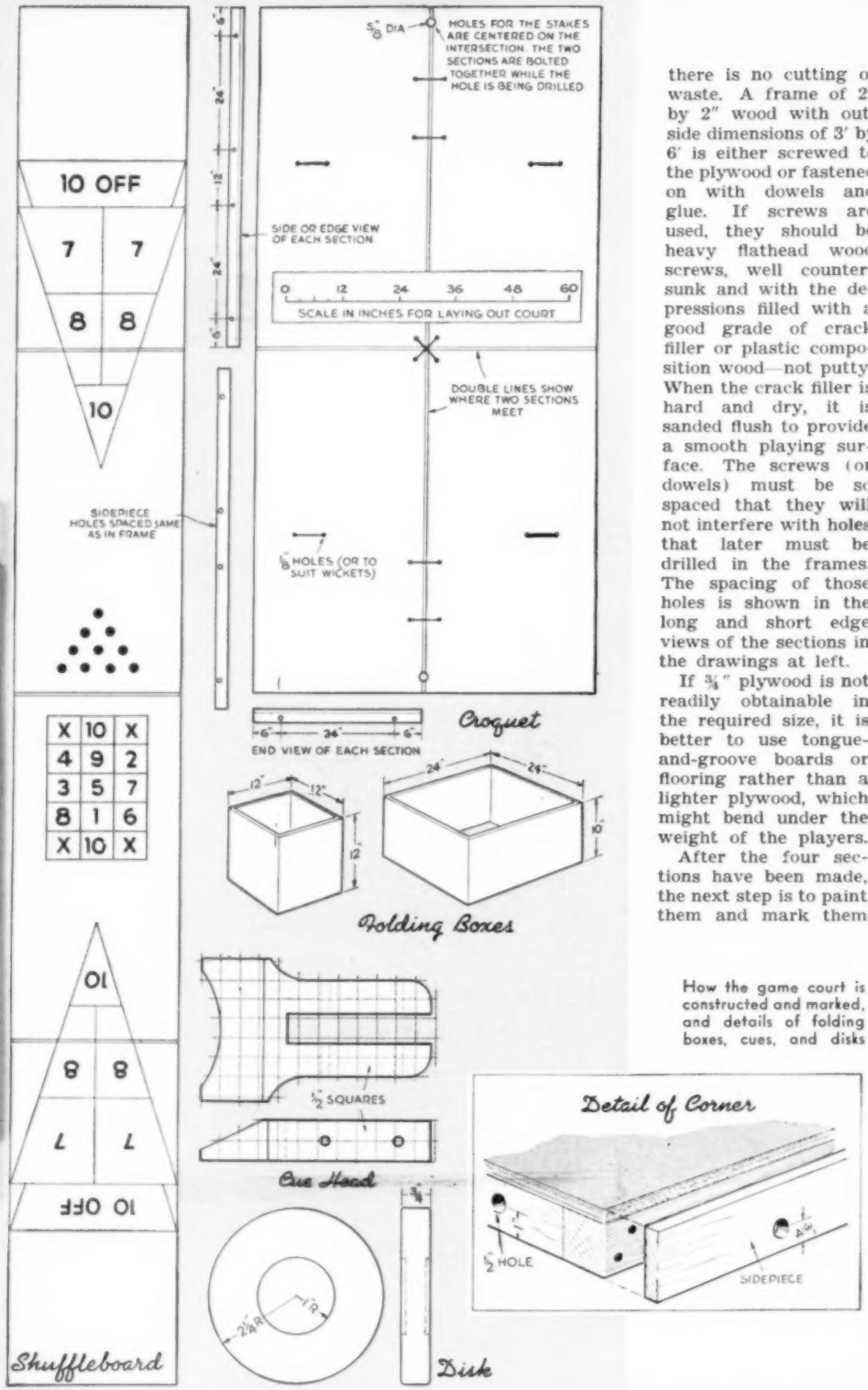
Three of the many games for which the court may be used are illustrated on the facing page. The first is shuffleboard; the second (lower left), bullboard played with bags of sand; the third, bounce played with table-tennis balls. The photo below shows how equipment is stored

there is no cutting or waste. A frame of 2" by 2" wood with outside dimensions of 3' by 6' is either screwed to the plywood or fastened on with dowels and glue. If screws are used, they should be heavy flathead wood screws, well countersunk and with the depressions filled with a good grade of crack filler or plastic composition wood—not putty. When the crack filler is hard and dry, it is sanded flush to provide a smooth playing surface. The screws (or dowels) must be so spaced that they will not interfere with holes that later must be drilled in the frames. The spacing of those holes is shown in the long and short edge views of the sections in the drawings at left.

If ¾" plywood is not readily obtainable in the required size, it is better to use tongue-and-groove boards or flooring rather than a lighter plywood, which might bend under the weight of the players.

After the four sections have been made, the next step is to paint them and mark them

How the game court is constructed and marked, and details of folding boxes, cues, and disks



for the games. Two coats of flat-finish paint are applied first. When dry, the lines, numbers, and other markings are painted on as shown in the drawing of the court as it appears when extended to its full length. Finally a protective coat of high-grade clear floor varnish is applied. The reason for using flat paint first is that it is difficult to paint the lines and numbers on a glossy surface. The paint will not "take" well and has a tendency to "creep."

If a really good-looking job is desired, it might not be a bad idea to have a local sign painter do the lining and numbering. Uneven lines and shaky lettering, while they would make no difference in playing the various games, would spoil the appearance

Any color scheme that suits the taste of the builder will do, so long as it is one that permits the markings to stand out distinctly. In other words, dark figures and lines should go on a light ground and vice versa.

The colors used on the game court illustrated are white, black, and bright red, with several shades of gray made by mixing the white and black in various proportions. A toned-down red was also obtained where necessary by the addition of a little black to the bright red.

The holes for croquet wickets and stakes are bored as shown in the drawing of the four sections when placed together to form a court 6′ by 12′. A target for darts is painted on the underside of a playing sur-

## RULES FOR FOUR GAMES

### SHUFFLEBOARD

THE following rules are a modification of those used for regulation shuffleboard, which is played on a court 52′ long.

Lay the four sections of the court as in the drawing at the left of the facing page. The game can be played by two or four persons, and the object is to shoot the disks onto the scoring area with the cues. If four play, two are partners against the other pair. Assuming that *A* and *B* are partners against *C* and *D*, then *A* and *C* stand at one end of the court and *B* and *D* at the other. The equipment is six red disks, six black disks, two cues with red marking, and two cues with black marking. *A* has the six red disks and *C* the six black. *A* leads off, and *A* and *C* shoot alternately until each has shot his six disks.

When shooting, a player's cue must not pass beyond the first section of the game court, and the player must not step over the nearest "10 OFF" line. The penalty for either of these faults is that the disk is removed from play for that inning and the player receives no credit for the shot. The penalty for committing both faults on the same shot is the same as the foregoing and a deduction of 5 points from the score.

In addition to shooting his disks onto the scoring area, each player tries to knock his opponent's disks off the good marks and onto the "10 OFF" space. A disk that comes to rest on a line scores the higher number, but a disk resting on a line bounding the "10 OFF" area calls for a deduction of 10 points. After *A* and *C*'s scores have been chalked up, *B* and *D* shoot the disks back. The game is won by the team that first reaches a predetermined total, or else a predetermined number of innings may be played.

### BULLBOARD

Bullboard is played with the bags of sand and the section of the court having the bullboard markings. Shoot from a line some 12′ or 15′ from the board. The penalty for overstepping the line is 5 points off for the first offense and 10 points each for subsequent foot faults. The object is to land the bags on the numbered board. Each player tosses four bags per inning. After five innings the scores are totaled, and the high man wins.

Landing on a distant X-square means doubling the score for that inning. Landing on a near X-square means canceling the score for that inning. Thus if a player lands on a near X with his first bag, his only chance of scoring for that inning would be to land on a distant X as well. In that case he is credited with whatever he makes on the other two bags.

### BOUNCE

The four sections of the court are laid end to end and the four bounce boxes are set up as shown in the accompanying diagram.

The game is played with three table-tennis balls and two paddles. There are two players, one at each end of the court. The object is to bounce the balls on the court, over the nearer set of boxes and into the far set. Landing in the large box counts 5, and landing in the inner box counts 10. The players alternate, three shots per turn, until each has had seven turns.

### DARTS

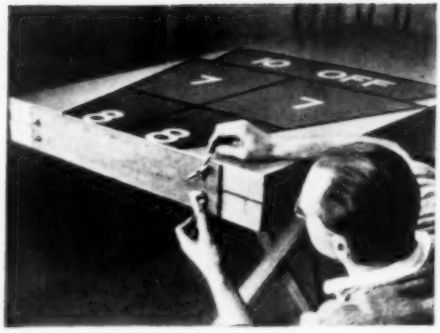
No set rules are needed for darts. The players should not step in closer to the target than a chalk line on the floor or a mark on the ground. A good distance for such a line is about 18′. As a matter of safety, everybody (players as well as spectators) should stand behind the line when any player is throwing the darts. A good way to play is for each contestant to throw six darts each time he is up, and the high score after a predetermined number of innings wins.

face as in the illustration that shows the equipment being packed into one of the sections. If preferred, a suitable paper target can be bought for a few cents from a store dealing in archery supplies, and this can be pasted on.

Once the four sections have been finished and painted, the next things to make are the sidepieces that hold them together. These sidepieces also serve as rims for some of the games in which the disks or balls must be prevented from sliding or rolling off the court.

There are ten sidepieces of hardwood $\frac{3}{4}$" by $2\frac{3}{4}$". Four of them are 3' long and six of them are 6' long. They are bolted to the frames of the sections with toggle bolts having shanks $\frac{1}{4}$" in diameter. The holes through which the toggle bolts pass are, however, bored $\frac{1}{2}$". This gives enough play so that the sidepieces can be bolted on in either of two positions: first, with their upper edges flush with the playing surface for games in which no rims are required; second, with their upper edges $\frac{1}{2}$" higher than the playing surface. The spacing of the holes has already been referred to, and is shown in the drawings. It is, naturally, important that the holes in the frames and in the sidepieces match accurately and that the spacing is uniform so that any sidepiece will fit on any frame.

Rims are not needed in some games—for example, the shuffleboard game—because if a player's aim is poor and he shoots a disk off the court, he should not be aided by rims. But in the modified croquet game, on the other hand, the disks that fell off the court would be out of play unless picked up and put back, so in this game the rims are needed.



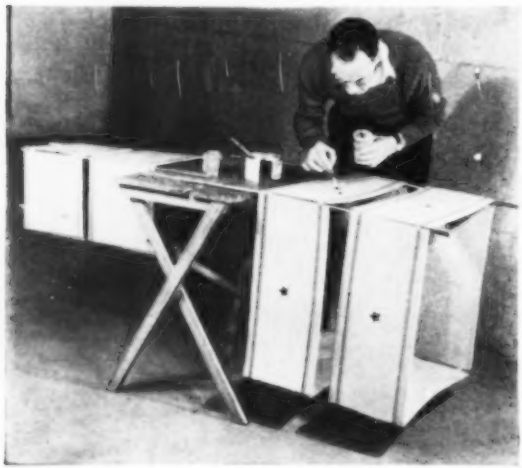

After the equipment has been stored away in one section, another is added as a lid, and the two are held together with end boards and toggle bolts

It is essential that the edges of the sections of the court meet evenly. The playing surface must be smooth and uninterrupted. There should be no difficulty in this connection when the court is laid on a cement garage driveway or a paved terrace, or on any floor indoors; but if it is placed outdoors on uneven ground, the court should be supported by blocks where there are depressions, and the sidepieces must be securely bolted on to hold the sections even. It should be clearly understood that the sidepieces are accessories, to be used only when necessary, and that for some of the games they need not be used at all if the ground is even.

If toggle bolts are not obtainable—although most large hardware stores keep them in stock—you can use ordinary bolts with the heads cut off and with about an inch of the smooth shank bent at a right angle to form a sort of square hook. Bolts so bent will require larger holes than the toggle bolts, and large washers will have to be used under the nuts. A better method is to cut horizontal slots to accommodate them.

With the four sections and the ten sidepieces finished, the game equipment and other accessories can be made, and some of them, if preferred, can be bought.

The games for which this court was arranged are listed at the



While the folding boxes used in the game of bounce are being painted, they are suspended on metal curtain rods or other rods nailed across a worktable. This makes them convenient to handle

left of the chart on a preceding page, and the equipment needed is shown along the top. Some items of equipment are used in more than one of the games, as shown by the check marks on the chart. Some of the games can be played with more than one kind of equipment. Thus tenpins, for example, can be played with balls or with cues and disks.

In addition to the equipment listed, a cloth bag for bolts, washers, nuts, and a monkey wrench is handy to have, as well as a slate or blackboard, an easel, chalk, and an eraser for scoring the games.

No set dimensions need be followed in making the equipment. The size of the various items can be governed, within limits, by the materials available.

*Cues.* Four or six of them may be made. The head is shaped as shown in the drawings, and the handle is 4′ 6″ long with a band painted around it. Each cue has a band of a different color to match the disks so that each player will know his own.

*Disks.* These are of hardwood, ¾″ thick and 4½″ in diameter. Their edges are slightly rounded to facilitate sliding, and each disk has two circular depressions, one on each side. These are 2″ in diameter and ⅛″ deep. The "floor" of each depression is painted, and this paint will not wear off because it is not subjected to friction when the disk slides.

*Folding boxes.* There are four boxes for the game of bounce. The game is played with table-tennis balls and paddles. The boxes are four-sided; that is, without any top or bottom. The sides are hinged one to another with leather hinges cut from a school strap or any available piece of leather. The hinges permit the boxes to be folded flat. When set up for play, two of the boxes form 12″ cubes and two of them are 10″ high by 24″ square.

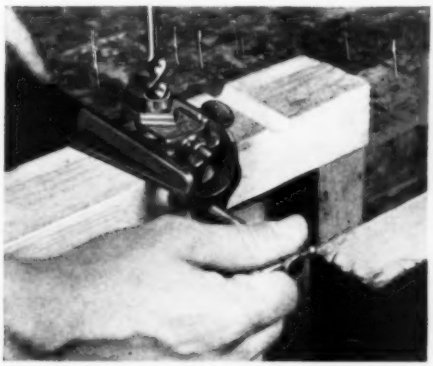
*Tennis-table balls and paddles.* These are purchased, although it is easy enough to make paddles, if desired.

*Darts.* Feathered darts can be obtained as a rule for about a dollar a dozen.

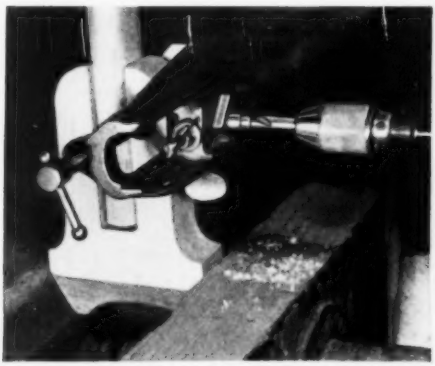
*Bags of sand.* Each bag is made of two circular pieces of strong cloth about 5″ in diameter, sewed together around the edges except for a small gap for the insertion of a funnel. The bags are filled with sand or lead shot, and the gap is sewed closed. The bag is then slapped as flat as possible and kept flat by a few strong stitches through the center.

The accessories and rules for four more games will be given next month.

Sand is poured through a funnel into the circular bullboard bags. The gap is then closed, the bag flattened, and a few stitches taken in the center



A doweling jig, if available, can be used in boring holes in the frames for the toggle bolts that hold on the sidepieces. Note at right one of the half holes for the stakes required in quoits and croquet



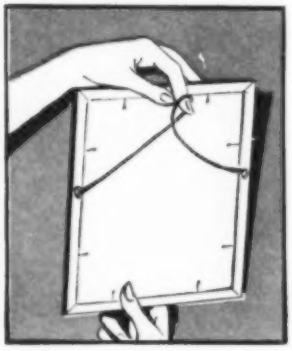
Boring one of the holes for the bolts that fasten the head of a shuffleboard cue to its handle. Because of the small diameter of the drill, a short piece of brass tubing is inserted in the jig as a bushing

# KEEPING THE

WAX KEEPS OILCLOTH BRIGHT. To prevent your kitchen oilcloth from becoming dull, apply a coating of wax periodically. The wax keeps the pattern bright and makes the cloth more durable. A cloth wrapped around a heavy iron facilitates polishing

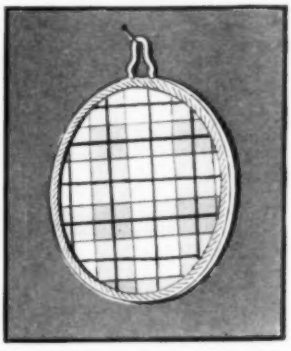
SUGARING DOUGHNUTS has always been something of a nuisance because you never knew when the "sinkers" were thoroughly coated if shaken in an ordinary paper bag. By using a bag made from transparent cellulose material, you can easily tell if enough sugar has been applied

IF YOU HAVE DIFFICULTY in keeping picture frames straight on the wall, try forming a loop in the wire, as illustrated below, before hanging it again. You'll find that the frame won't slip



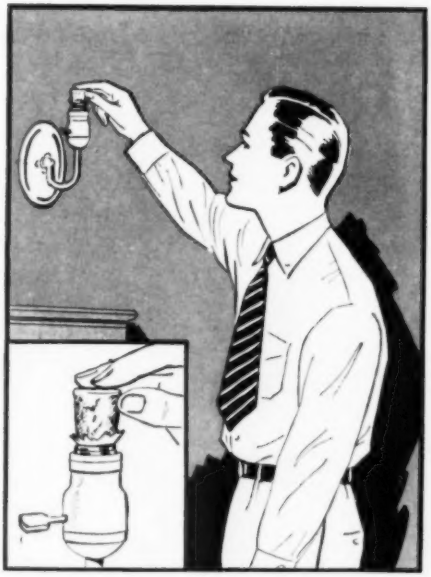
A PAIR OF PLIERS is a handy tool to keep in the kitchen-table drawer. When home-canned fruits and vegetables must be opened, use the pliers to grip the rubber ring. One pull and the ring is loose; then unscrew the cap

DON'T THROW AWAY those old garters before taking off the hooks. Miscellaneous uses can be found for the hooks, such as attaching them to pot holders for hanging on the wall



# HOME SHIPSHAPE

**NEW USE FOR OLD CURLING IRON.** When curtains, clothes, and other materials are to be dyed, a curling iron forms excellent tongs for turning the fabrics in the dyeing bath. Fingers won't get stained, and the material will not slip off as it does when a stick is used



**REMOVING BASE OF BROKEN BULB.** If an electric light bulb breaks off in the socket, you can remove the metal base without danger of shock or cutting your hand by pushing a cork into the base

**THOSE SLEEVELESS GARMENTS** that are always sliding off the wire hangers and falling on the floor can be prevented from doing so if the ends of the hangers are bent up as shown below

**SMALL RUBBER WASHERS** for special purposes may be cut from old rubber bottle stoppers that have been bored to the correct size. Use a single-edge razor blade wet with water as a knife

**SILENCING ROLLER CASTERS.** To soften the sound of casters as they roll on the floor, wrap rubber splicing tape around the wheels, as below. Two or more layers of the tape may be used

# Here's What I Want

## HER views / IT MUST BE PLANNED

By DOROTHY DUCAS

THE female of the species approaches the fascinating business of home building quite differently from the male. She starts out, not with a budget of expense or a predilection for stone or wood or stucco in mind, but with a plan of living firmly entrenched in her heart. She begins to visualize herself inside her house before there is even a blueprint.

The result is that a woman is apt to be twice as demanding as her husband about how a house works. She may have put up with all manner of little irritations in the course of living in rented houses. But that's exactly why she says of her own house: "No more running up and downstairs to answer telephones! No more waiting while the water gets hot enough for dish washing! No more taking time out to press an evening dress every time I wear it, because the hem line got wrinkled in that closet with the pole too low to allow the dress to clear the floor!"

So, being a woman, the first thing I ask about a house is: "How does it enhance the things I want to do in it?" I want my house to turn a good-looking face to the world, but I would much rather be able to say: "It's the most comfortable house in the world!" than "It's a perfect reproduction of a house in Williamsburg, Va." No matter how impressive its facade, if its rooms were not arranged so that answering the doorbell required a minimum of effort, seating eight persons comfortably in the dining space presented no embarrassing problems, or bedding the children down for the night could be accomplished out of sight and ear-

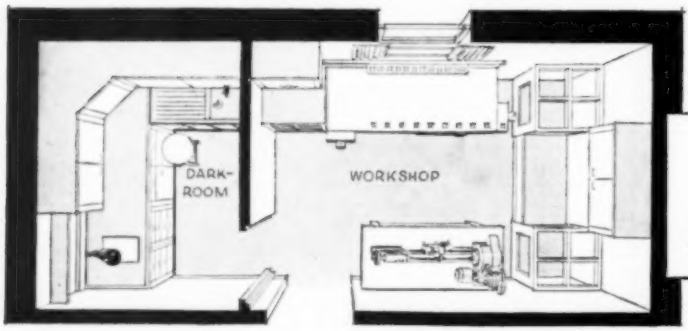
## HIS views / FIRST, DURABILITY

By T. E. WHITTLESEY

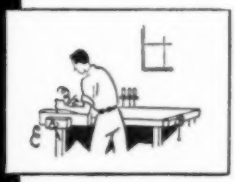
THIS full and free expression of what I, as a mere man, want in our new house is probably going to unleash something that will set a new high in family arguments. Nevertheless, this is my chance, free of interruption, and I must make the most of it.

First and foremost, I want a house that will require in the years to come the absolute minimum of maintenance cost. That embraces a number of things: exterior materials that can hold their own against sun, wind, storm, and frost; interior walls that will not cry out for redecorating every other year; materials and methods of construction in which durability has been placed first.

If the exterior walls of my house could be




Workshop and darkroom can share the laundry space in the basement

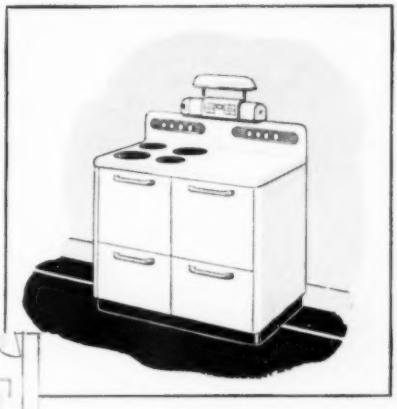


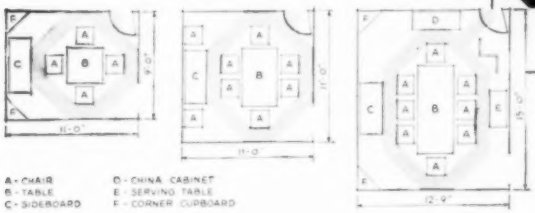
# in a House of My Own

## FOR COMFORT AND CONVENIENCE

shot of guests in the living room, it would not suit me.

I want a house that will enable me to live the way I like to live. The color it is painted outside—or the fact it does not require paint at all—won't affect my living inside. But I want a large living room and a small dining room, for I enjoy having lots of guests after dinner and abhor large numbers at the dining table. The windows can be wood or steel, casement or double hung, depending on the architectural style, but I must have bedrooms with morning sun, to start each day cheerfully. I want my range to be electric, because I

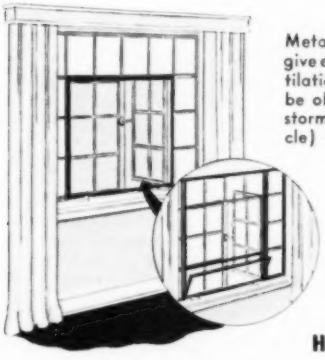





"I want my range to be electric . . . all lighting to be scientifically planned and considered part of the decoration . . . the dining room to seat eight persons." At left are three dining rooms with an adequate "path of service"

## NEXT, AUTOMATIC OPERATION

built of material that would never need paint, I'm for that. On the other hand, paint would be my first choice for inside wall surfaces—a paint that will stand washing if necessary to keep it decently clean. I suppose I'd tire of an interior which had all its walls painted, so I'd steer around that danger by having, say, hall and living room plastered in a sand finish which would never need either paint or paper. I've seen such walls plastered in a sort of warm putty color and am told that mixing a yellow rather than a gray sand with the lime and other ingredients gets that result. It strikes me as a background color that would never grow tiresome. Another break from the possible monotony of painted plaster would be a den or library sheathed in wood.



Metal casements give excellent ventilation and can be obtained with storm sash (circle) and screens

I would have as little exterior woodwork as the law allows—certainly none of it for porch floors, outside steps, and trim; for if it is not kept painted, it rots. Wood sash are off my list for the same reason. I'd have metal casements. Casements rather than double-hung sash? Yes, for then the whole window opening can be used for ventilation instead of only half of it. Screens? Yes, inside the casements, of copper in both mesh and frames—a type that does not have to be opened when operating the casements.

As to the roofing, I'm not sure. Slate, or flat tile, or asbestos shingles, provided the

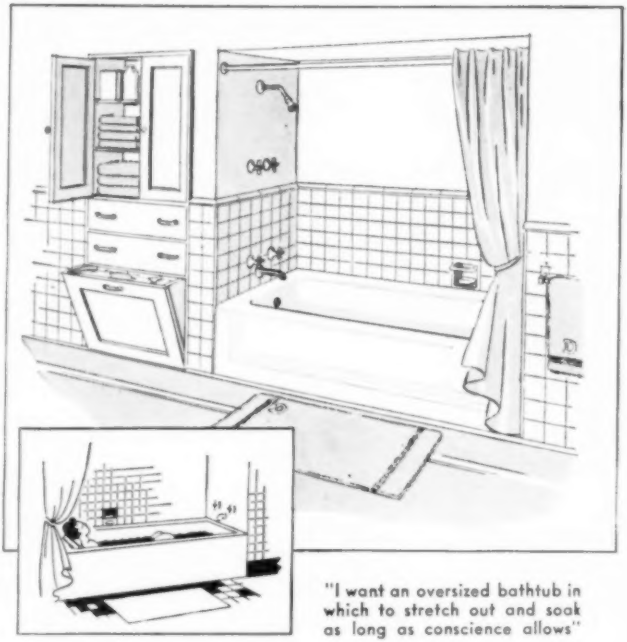
## HER views

## LONG BATHTUB, LOTS

learned to cook on an electric range and achieve best results via electric cookery. I want an oversized bathtub in which to stretch out and soak for as long as conscience allows at the end of a tiring day. I want a small book-lined study where I can work, barricaded against interruptions, noise, and distractions.

I want lots of shelves and cabinets for storing household equipment—everything from pots and pans and sleds and galoshes to books, bicycles, and extra winter blankets.

I have lived in a house with irregular floor boards that high-heeled shoes invariably caught on, that collected dust between their cracks, and would not stay smoothly waxed. But when I build a house, the floor



"I want an oversized bathtub in which to stretch out and soak as long as conscience allows"

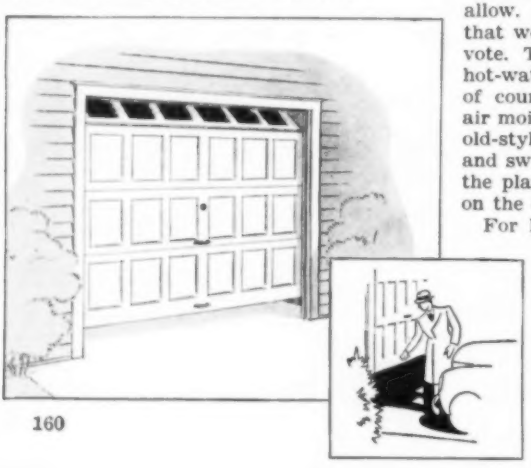
## HIS views

## INSULATION, MODERN

last named have sufficient thickness to avoid a resemblance to these paper-thin coverings. I might even consent to wood shingles if I could get them of redwood, as I understand this wood is strongly fire-resistant, at least to falling sparks and embers.

My second fundamental requirement in a house—and it is very little less important than the first—is that it will do its own work. Everything that can be made automatic is going to do its own work. Perhaps I can't afford one of those garage doors that open to the car's lights or a radio signal, but I'll get as near to it as the budget will allow. Practically any electrical gadget that works without being told will get my vote. Thermostatic heat control, aquastatic hot-water control, ice-making refrigerator of course, humidistatic control of interior air moisture, circuit breakers instead of the old-style fuses, adequate lighting outlets and switches; all these would have to be in the plans and specifications before I'd sign on the dotted line.

For heat I must have an oil burner, an



"Perhaps I can't afford one of those garage doors that open to the car's lights or a radio signal, but I'll get as near to it as the budget will allow. Practically any electrical gadget that works without being told will get my vote"

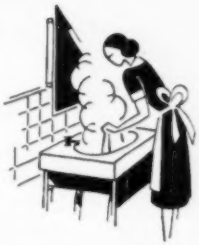
## OF HOT WATER, CLOSET SPACE . .

must be beautiful to look at, easy to walk on, reasonably simple to care for. That means linoleum or tile in kitchen, baths, and children's rooms, wall-to-wall carpeting in living room, dining room, and bedrooms.

I have curled up in chairs and fiddled with inadequate reading lamps until they sent enough light over the pages of my book to keep me from squinting. But when I build a house, all the lighting will be scientifically planned to shine where and with the intensity it should. There won't be a comfortable chair, table, or desk without its special lighting fixture or lamp, in my house.

I have shared a closet with my husband and seen my flimsiest gown rub shoulders with his heavy tweed coat. But the master bedroom of the house I build will have two master closets, each planned in minute detail for the garments it is to shelter. My closets will be as big as little rooms, with enough drawers built into their walls to enable me to dispense with chests in the bedroom itself. Then I'd have room for the *chaise longue* I never have been able to house!

Of course, I want a house which is fire safe, insulated, weather-stripped—no drafts, please!—automatically heated, with recessed radiators or registers that won't interfere with my decorative scheme. I want a house complete with screens and storm windows, with plumbing that is as noiseless as it is possible for plumbing to be—and with all the valves and traps plainly marked so I can find them in an emergency. I want automatic hot water, lots of it, day or night—which means a very large storage tank or an instantaneous system. I want a house wired to bring me more electricity than the house my grandmother lived in, for I anticipate using electrical appliances in it which are not yet dreamed of by their inventors.



A big hot-water tank or an instantaneous system is desirable

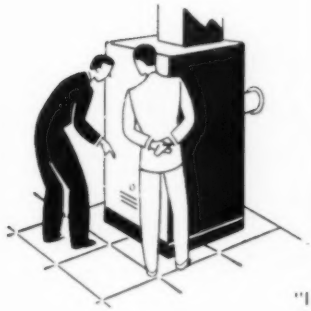
Attic and basement must be well protected against termites, ants, roaches, rats, mice, and even squirrels—for show me a woman who can take meeting wild life in her own house with equanimity!

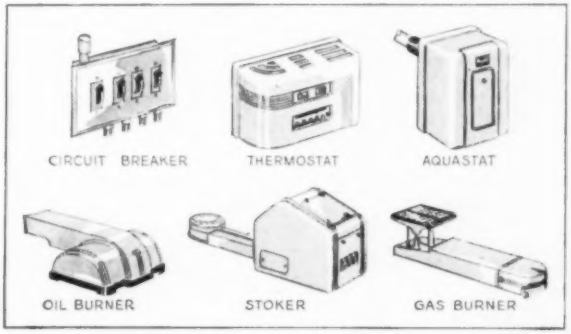
When it comes to decorating my house, I expect to spend many weeks, even months

## HEATING, ELECTRIC LABOR SAVERS

automatic coal stoker, or gas—whichever is the most economical in my community; any one of the three will let me out of a never-ending chore. It goes without saying that insulation and the best weather stripping are other "musts."

When I get those two major groups—durability and automatic operation—off my list, I'm inclined to listen to a few words from the rest of the family. But before I give over the floor and lose my turn to speak, perhaps I'd better jot down a few more demands. Some of these might at least serve as trading points—to be sur-






"I must have an oil burner, an automatic stoker, or gas . . . thermostatic control, aquastatic hot-water control, and circuit breakers"

## HER views / SCIENTIFIC LIGHTING

planning color schemes for every room. Each room should have the color and pattern which best suits its personality and the personality of those who will use it. I would not dream of putting warm putty color anywhere in the house. It is one of the most trying colors in the world for a woman of average coloring. As is the flat, muddy cream color so favored by apartment-house painters. Stark whites, warm grays, pinky beiges so light they hardly look pink except to someone who has watched them being mixed, do much more to set off feminine attractions.

I think I'd steer clear of plaster walls entirely, unless I were building for occupancy 'way in the future. For plaster takes so long to dry, and I know the difficulties of decorating over not-well-dried-out plaster.

I should consider the lighting of my house as part of its decoration, for the way in which electric light falls on walls, furniture, rugs, and drapes enhances or detracts from the whole effect. And sunshine through a picture window or filtered through Venetian blinds (which I'd have everywhere) might enhance my color scheme by day.

And, being me, a sun-worshipper but no athlete, I'd hold out for a sun deck or inclosed terrace where, on fine days, I could sit and get sunburned without moving a muscle or affronting the neighbors.

Some of the things I want I realize are beyond my budget. Yes, I know it without even consulting the man of the house. But I should like to plan my house for their addition at a later date when, so one fondly dreams, they might be possible. I would hang on to the essentials of construction, such as room sizes and room arrangements, closets, termiteproofing, automatic heat and hot water, for they would be costly and inconvenient to add or alter later on.

The things I have set my heart on in a home of my own are what years of living have taught me I require for efficiency and contentment. I want these things not, as my husband does, because they represent good value, but because I know they will be positive influences upon the kind of life I shall lead in my house.

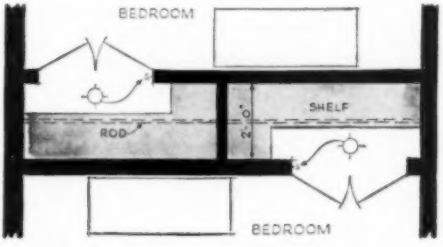
## HIS views / WORKSHOP, DARKROOM

rendered as a last resort in a compromise.

The number and shape of closets would certainly receive my critical scrutiny. Any closet which is intended to hold clothes must be wide rather than deep. Two feet inside depth is right for a rod and its hangers; more than that depth is a waste of room and an inconvenience. In the bathrooms, the usual medicine cabinet is all right so far as it goes, but it needs a big brother. Storage space in large volume is needed, preferably in an attic.

Custer's last stand will pale into insignificance beside my fight, if it should become necessary, for a workshop in the new house. If a photographic darkroom can be combined with it in some way, I'll ask for little more here below. A compromise of sorts is not altogether unexpected, in this rather personal plea for space, and already I have a plan whereby the shop and darkroom can share the space that would naturally be required in the basement for a laundry. And we certainly must have a laundry.

Style, if it should mean the trappings of some historic way of building, has little appeal to me. What I want is an honest expression of what the building is to be—my family's home. As such I should expect it to reflect something of our collective tastes and our manner of life, and thus become a good neighbor in its community.




Closets for holding clothes should be wide, not deep. A two-foot depth is adequate

There are no restrictions as to the size or design of the house provided it can be built for $10,000 or less. Left, a $6,300 Cape Cod design; right, a $4,200 house

*Try for a Prize in Our*

# $1000 CONTEST

## *on "The Home You'd Like to Build"*

You still have time to enter our home-planning contest. Its object is to encourage you—and other readers—to get down on paper your ideas as to the design of a house that will best fit your own needs and income, and be suitable for economical construction in your own locality. The following awards will be made:

| | |
|---|---|
| FIRST PRIZE—The services of an outstanding architect (or any architect of your own choice) to draw the plans and supervise the building of your home, or a cash award of | $500 |
| SECOND PRIZE | 200 |
| THIRD PRIZE | 100 |
| FOURTH PRIZE | 50 |
| FIFTH PRIZE | 25 |
| 25 PRIZES, $5 each | 125 |
| TOTAL | $1,000 |

Each entry should consist of: (1) Floor plans or sketches showing the layout and dimensions of the rooms. (2) A sketch or other representation of at least the front view or elevation of the house; and also one or more of the other elevations, if desired. (3) A brief description of the house and the materials of which it is to be built (its cost should not exceed $10,000). (4) A statement as to the size of the family and the income group for which the house is intended. (5) A statement that the design is original.

The drawings should be on good quality paper so as to withstand handling, and may be either in ink or pencil. The accompanying description should be typewritten if possible.

Only one entry can be made by each person, and no entries will be returned. The prize-winning designs will become the property of this magazine to be used in any way desired.

The competition will be judged by a committee of architects and editors of POPULAR SCIENCE MONTHLY. The decision of the judges will be final. In case of ties, duplicate prizes will be awarded to the tying contestants. The contest is open to all except professional architects and employees of Popular Science Publishing Co., Inc., and their families.

The contest closes April 15, 1941, and entries must be mailed fully prepaid and in an envelope or flat package (not rolled) on or before that date. Address the House Planning Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

Figured at 35 cents a cubic foot, this California style house could be constructed for $5,250

This type of house is often referred to as an Early American farmhouse design. Cost, $8,050

In this modern treatment of a window wall, cabinets up to the sill height are built at either side of the radiator, which is closed in with a removable panel. Bookcases extend up to the ceiling on both sides of the window, and one of them contains a drop-leaf bar

# Built-In Bookcases

By
**JOSEPH ARONSON**
*Author of The Book of Furniture and Decoration and The Encyclopedia of Furniture*

LEADERS in home decoration suggest utilizing waste space for the built-in effects so much featured in modern design. A reasonably competent homecrafter can design and execute many such projects by following the general scheme suggested in these sketches and adapting the dimensions as necessary to the room that is to be modernized.

This wall treatment has been developed to utilize to the utmost advantage a window wall with radiator, as shown in the circle. Cabinets up to the sill height fill the space on either side of the radiator, and the radiator is covered in front by a removable panel. At each side of the window there is a bookcase extend-

## ANNOUNCING A NOTEWORTHY NEW SERIES

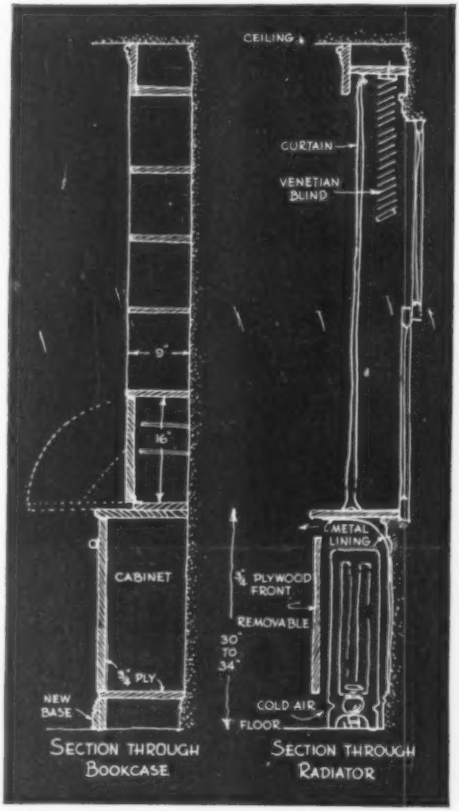
**This article and the one on page 169 describing a Dutch Colonial hanging cupboard are the first in a series prepared especially for POPULAR SCIENCE by one of the foremost authorities on furniture design and interior decoration. Mr. Aronson's studio in New York is a full-scale, busy workshop in which skillful craftsmen produce not only models for commercial manufacture, but also many special pieces of furniture for the interiors he designs for his own exclusive and wealthy clientele.**

**In this series he intends to discuss general methods of modernization and give plans for individual furniture projects. He will approach the subject from the standpoint of (1) good design, (2) the selection of inexpensive materials that are everywhere available, (3) the elimination of tricky processes and gadgets, and (4) the use of styles that conform to those being currently stressed by first-rank American decorators.**

# and Bar

ing up to the ceiling. A fascia board across the top is finished with the molding of the room so as to form a pocket between the bookcases for the curtain rods and Venetian blinds. One of the bookcases can be fitted with a drop lid, which may be used to form a bar, a desk, or a radio cabinet.

Dimensions are given only in a general way, as this unit will be planned for the individual room. Good clear pine boards, $\frac{7}{8}$" thick, are suggested, except that the doors, drop lid, and radiator facing panel should be $\frac{3}{4}$" plywood.




**The bookcases and cabinets are of simple construction, but their design gives them distinction. The illustrations are Mr. Aronson's own freehand sketches**

Various types of lamps are suitable for home-workshop lighting, but one of the best is what is known as a 14" R.L.M. dome with a porcelain socket and a 150-watt frosted bulb. To give illumination at any point needed, these lamps may be hung by means of hooks, as above, on wires stretched across the shop

# WIRING A HOME WORKSHOP for LIGHT AND POWER

By EDWIN M. LOVE

JUST as the average home workshop grows up in the basement or garage, the current for its lighting and power are drawn from the original wiring, with the result that power needs soon outgrow the original supply. Extension cords should not and cannot be multiplied, and something must be done about it.

The only answer to the problem is new wiring. In spite of the variety of materials on the market and the endless arrangements of shop equipment, a really simple and universal plan can be worked out. The room shown in the wiring diagram is 12′ by 20′, and it is assumed there are ten machines in it. If your shop is smaller, no matter; just reduce the number of outlets, and if necessary use only one machine circuit.

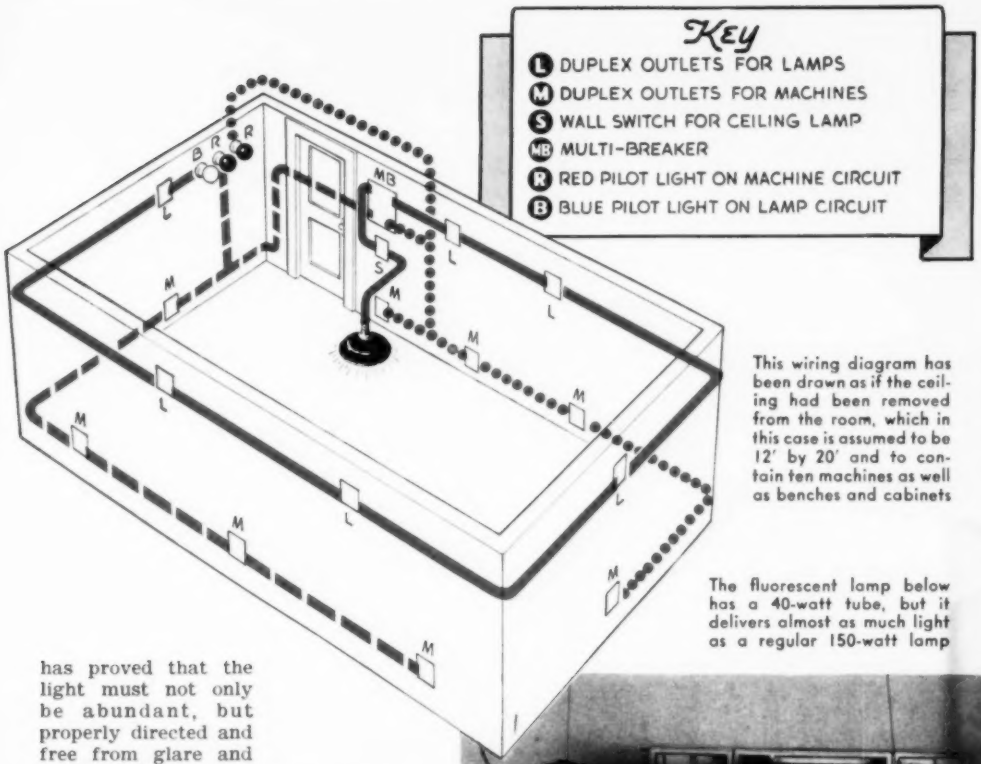
In this layout two circuits are given to lighting, and two to power. In the center of the ceiling is a stationary lamp controlled by a switch at the door; it provides light for moving around in the shop and can be turned on or off as the owner enters or leaves. On a second circuit are six duplex outlets about 7′ from the floor, or just under the ceiling, if it is low. In these outlets the various portable lamps are plugged.

Eight duplex outlets for machines are located 3½′ above the floor. With all machines plugged in, there is still a connection for electric gluepots or soldering irons.

All circuits connect to a "multi-breaker" box near the ceiling. This box contains breakers that open on overloads and close with the flip of a button; in other words, they take the place of fuses. With a box of 60-ampere capacity, the light circuits can be set at 10, and the power at 15 or 20 amperes, depending on the size of wire used.

As a reminder that power is on, a small red light wired permanently in each machine circuit, and a blue one in the lamp-outlet circuit, will glow whenever these circuits are "hot."

That's all there is to the plan. Now for comment on the lighting. Modern research




This wiring diagram has been drawn as if the ceiling had been removed from the room, which in this case is assumed to be 12′ by 20′ and to contain ten machines as well as benches and cabinets

has proved that the light must not only be abundant, but properly directed and free from glare and abrupt contrast.

Lighting fixtures on the market vary greatly in design, price, and efficiency. Since the home-workshop owner usually works alone, or at any rate with not more than one or two others, it is evident that all parts of the shop do not need to be lighted for detail work at the same time. That is why portability is so desirable, for the lamps can be placed where needed. Regardless of the position of a machine, the light can be changed to suit. All this makes wiring easier and less expensive, as four units besides the center fixture will care for all needs.

For bench work, where close joints are made, or for matching colors in painting, there is nothing better than the cool-burning, current-saving fluorescent lamps. These are obtainable as either stationary or portable fixtures, and they can be made in the home workshop. (See "Build Your Own Fluorescent Lighting Fixtures," by Harold P. Strand, P.S.M., Aug. '40, p. 176, and Sept. '40, p. 178.)

Probably the next most suitable shop lamp is the 14" standard R.L.M. dome with a 150-watt frosted bulb in a porcelain socket, or a semi-indirect

The fluorescent lamp below has a 40-watt tube, but it delivers almost as much light as a regular 150-watt lamp

lighting globe that turns direct rays back into the reflector. The R.L.M. dome is porcelain enameled, green outside, white inside, and if kept clean will be "tops" for many years.

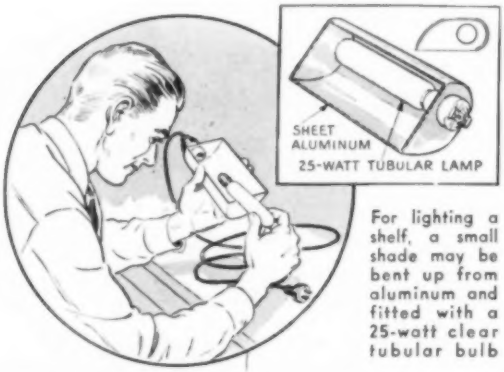
Fit each portable lamp with a hook or snap, and hang it from hooks turned into the ceiling; or, better still, arrange a system of tightly stretched wires along which the lights can slide. They will then have to be lifted off only occasionally. In basements with scant headroom, the wires can be run between the joists to give more clearance.

Individual lights mounted directly on the machines, which throw spots of light on the work just where needed, are sometimes desirable. They can be plugged into the same duplex outlet as the motor. If much vibration is present, it is better to support them with swinging wall brackets, or else buy special vibration-resisting bulbs.

It is generally understood that most wiring falls under the description of knob-and-tube, flexible armored cable, and conduit. The kind used will depend on local ordinances, and before any wiring is attempted the owner must check up on them. Most cities require the work to be done by a licensed electrical contractor, or else by the owner himself after taking out a permit, and subject to inspection. This means that the owner is guaranteed a reasonably safe job.

For most home-workshop wiring, the flexible armored cable known as "BX" is usually best. Thread it through holes in joists, carry it along running boards with clips or staples, or fasten it lengthwise to the timbers. Where conduit wiring is demanded by the Electrical Code, use modern thin-walled tubing that needs no threading and is put together with clamp-on connectors.

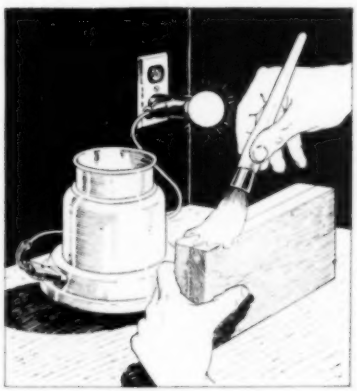
If there is a 115-230 volt, three-wire service connected to the house, the motors should be connected to the 230 volts. Most motors are wound for use on either voltage, and are furnished with directions for connecting. Three-wire cords and outlets should be used for proper grounding of the machines, and this is required in many localities.

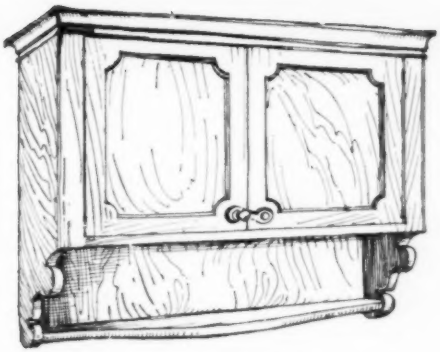



For lighting a shelf, a small shade may be bent up from aluminum and fitted with a 25-watt clear tubular bulb

A multi-breaker is better than an ordinary fuse box. This one has a locked door so that the owner can open breakers to keep the machines from being used in his absence

Plenty of duplex outlets are desirable, not only for the machines, but also for electric gluepots and soldering irons





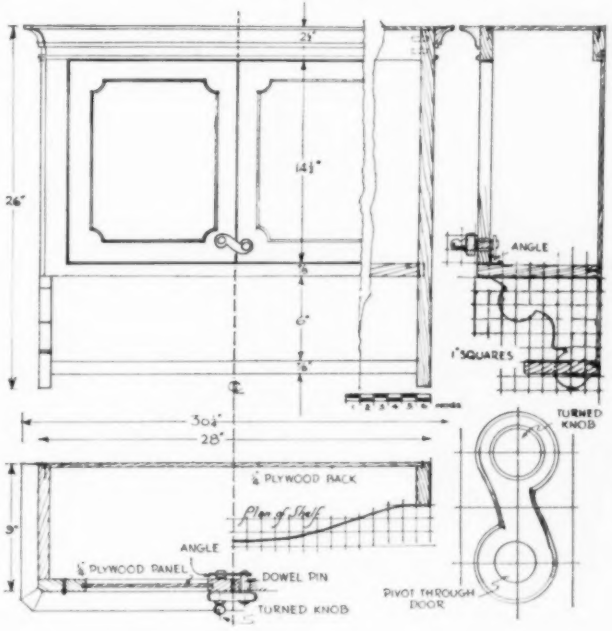
# Dutch Colonial Hanging Cupboard

ANY homecrafter whose wife haunts antique shops will find a special thrill in presenting her with this Dutch colonial hanging cupboard—homemade, just as the original was. Such wall cupboards were made by the Dutch and German settlers of the Walkill Valley in New York State for use in the substantial stone houses they built there in the early 1700's. Just as they used the materials they found growing at hand, in this case white pine, so can you make this cupboard of a choice of native woods: pine, birch, walnut, cherry, and oak.

Sides, shelves, and framing should be $\frac{7}{8}$" thick; top, back, and door panels may be $\frac{1}{4}$" plywood, or of solid wood. If you cannot run the top cove mold yourself, you can adapt the standard $1\frac{3}{8}$" by $1\frac{3}{4}$" cove mold available from any lumberyard, but it would be better to thin off the coarse top edge. The bead below the cove is a $\frac{3}{8}$" half-round, mitered at the corners. The corner is shown chamfered $\frac{1}{2}$", but this is optional. The latch consists of a loose dowel pin through the door; on the outside it has a lever with a turned knob; on the inside it fastens to a plate that closes against the inner side of a 1" by 1" angle screwed to the floor. This angle also stops the left-hand door.

The finish is what finally makes or spoils the cupboard as furniture. The original has a medium brown finish like tobacco leaf, worn to a satiny glow. Clean and sandpaper every corner and joint and edge until it all feels silky smooth. Oak oil stain is recommended because it will not raise the grain. Stain with several thin coats so you can judge the depth of color; then sandpaper lightly with No. 00 finishing paper, being extra careful at the edges. Two thin coats of pure white shellac should follow. Sand the first coat until it is almost gone; only then apply the second coat. This coat, after a preliminary sanding with No. 4/0 paper, may be rubbed to a satin texture with pumice stone and crude oil. The antique effect is sometimes improved by using a dark wax over the last rubbing. We do not advise deliberate highlighting, but the application of a few well-rubbed coats of dark wax will accent the planes and enrich the effect.

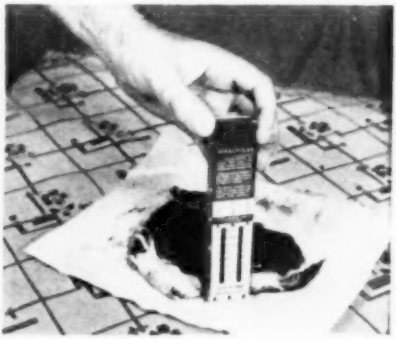
*Next month: Medicine Cabinets—a selection of the best designs among the hundreds submitted in our Medicine Cabinet Contest.*



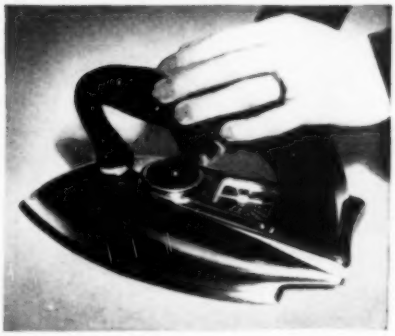
# New Appliances

Designed for a modern kitchen, this washer is sink high

STEAK METER. Rare or well done? This gadget tells how long to broil the steak. On the reverse side is a butter measurer



HEAT CONTROL FOR IRON. A temperature meter indicates if the dialed fabric heat has been obtained or regulation is needed



REFERENCE CHART on the new kitchen scales below translates cups into ounces. Scales can be locked if package hides dial

WASHER CONTAINS GERM-KILLING LAMP. Ultra-violet, the health ray of sunshine, is brought to the laundry by an ultra-violet lamp installed in a new electric washer. A shield fits over the lamp to direct the rays downward

# for the Household

**COMBINATION SERVING AND DINING TABLE.** This piece is designed for the small apartment where the furniture must serve a double purpose

For dining-table use, trays are supported side by side

**PAPER TOWELS** are merely pushed into place on this nickel-plated holder, which is screwed to the wall. The roller turns freely

**FLIPPING A LEVER** on a new stopper compresses the rubber cylinder and seals the bottle. Below is the vacuum-bottle model

**ONE COLOR, TWO TONES.** A ribbed design makes this nonskid rubber rug of one color appear to have two different shades

Mounted on casters, the mahogany table may be wheeled from kitchenette to living room with the food on the trays

# Care and Repair

By BENJAMIN NIELSEN

RIGHT now—before the busy season begins—is the time to check over the garden tools and send all the cripples and invalids to the "fix-it" corner of the workshop. There is a definite sense of satisfaction in working with tools that are bright, sharp, and in tiptop working order.

Let's examine the lawn mower first. Perhaps all it needs is a good cleaning, some adjustment, and a bit of paint. After removing the wheels and cover plates, thoroughly clean the mower, including the bearings and movable parts, with a stiff bristle brush saturated with kerosene or gasoline. The latter has the advantage of drying quickly. Then reassemble and oil all parts. Securely tighten all bolts, nuts, and screws.

If there is any lost motion in the cylinder-shaft bearings, the looseness should be taken up by means of the adjusting collars or set screws to be found on one end of the cylinder shaft. Some newer types of mowers are equipped with ball bearings that need no adjustment, while others have adjustment provided for this type also. A mower, even if it has absolutely sharp blades, will not work properly if there is any up-and-down play in the reel.

After the lawn mower has been in use for several seasons and the cutter blade has been adjusted upward time after time, the sharp front edge of the stationary cutter bar becomes worn down, resulting in in-

Fig. 1. When worn down, the working edge of the stationary cutter bar is filed sharp and straight

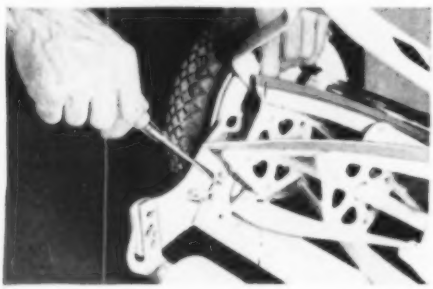


Fig. 2. The cutter bar is adjusted by loosening one screw a bit and tightening the other to match.

Fig. 3 (below). To make the mower run backwards for grinding, the small gears must be transposed

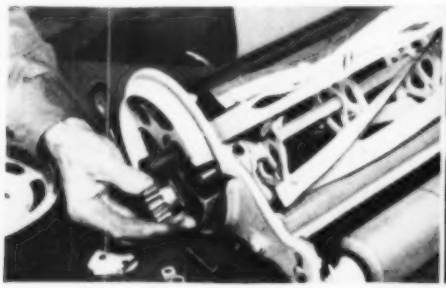
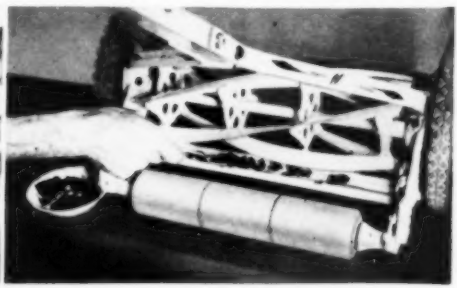


Fig. 4. The grinding is done with a smooth paste of Carborundum powder and automobile oil, which is distributed evenly along the stationary cutter bar



# of Garden Tools

creased friction. This makes the mower hard to operate. To correct this, the cutter bar is removed from the machine. With a flat mill file, reduce the shoulder on the cutter bar, making the edge sharp and perfectly straight along its entire length (Fig. 1). After replacing the bar, set it by means of the adjusting screws (Fig. 2) so that it makes contact with the revolving blades.

Ordinarily the lawn mower should be sharpened at least once a year, and at shorter intervals if an unusual amount of cutting is done. The simplest and most effective method of home sharpening consists of removing the wheels and covers over the pinions and reversing the pinions, side for side, as in Fig. 3, so the blades run backward, and then replacing the wheels. It may be necessary to reverse the pawls also. Test for this by running each wheel backwards and noting if the cylinder turns backward with it.

Mix fine Carborundum powder and automobile oil to a smooth paste. This is better than attempting to use emery and similar compounds, which do not possess sufficiently rapid cutting power. Distribute the paste evenly along the stationary cutter blade (Fig. 4). Care should be taken not to permit any of the abrasive to come in contact with moving parts. Then turn the

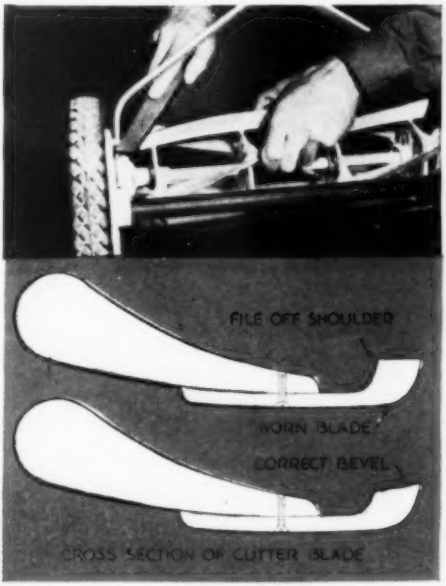
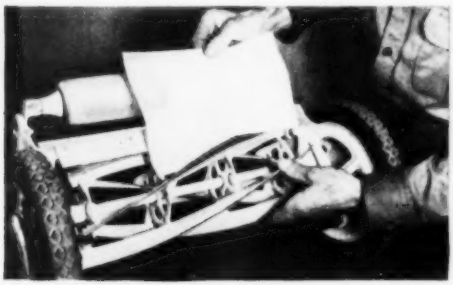
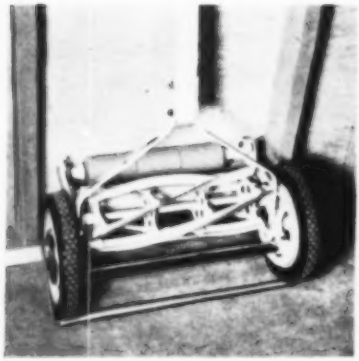



Fig. 5 (left). The mower is pushed upside down until the blades spin freely. They are then tested with paper as in Fig. 6, below. If the ends are too high, file them as in Fig. 7 (the upper photo)





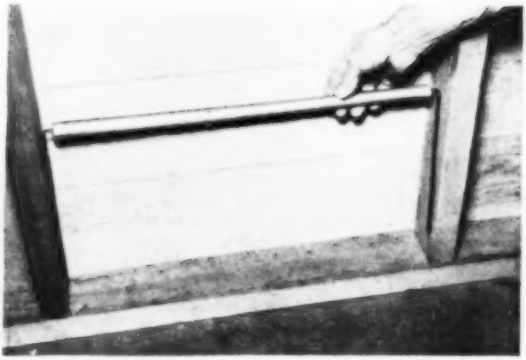


Fig. 8. To store a lawn mower without wasting space, make a stop or holder for the wheels from a broomstick and two pieces of wire. Fig. 9 (right). This folds out of the way for sweeping the floor

mower over and push it back and forth on a concrete floor or sidewalk (Fig. 5). Keep it moving until the blades continue to spin for several seconds when the machine is halted abruptly.

Test for sharpness by inserting paper between each blade and the cutting bar (Fig. 6). Be sure to test each blade for its entire length. If the paper slips at any point, it will be necessary to raise the cutter bar, add more Carborundum compound, and repeat the grinding operation. As each blade is tested and found satisfactory, it may be marked.

During the sharpening process, the ends of the revolving blades are not ground as low as the other points, and an annoying click may result as these points strike in revolving. These high points can be filed off as in Fig. 7.

Remove all grinding compound, replace the pinions in their original position, and reassemble.

To keep the mower in good operating condition, it should be wiped clean and dry after use. Wiping metal parts with an oily rag will prevent rust. A coat of good paint every two or three years greatly improves the appearance of the machine and adds to its life span. It goes without saying that a mower stored under shelter lasts longer and needs far less repair than one left at the mercy of the elements.

No one denies that a lawn mower is an awkward implement to store. The holder illustrated in Figs. 8 and 9 is convenient and easily made. It consists of a length of broomstick and two pieces of heavy wire. The wires should be just long enough to accommodate the mower as the stick rests on the floor. Holes are drilled in the ends of the broomstick to take the bent ends of the wires. The opposite ends of the wires are bent out and driven into studding a few inches above the floor. The stick that prevents the mower from rolling may be folded back against the wall when sweeping or cleaning the floor.

Is your old garden spade dull or rusty? For a few cents a local blacksmith, if one is available, will heat the edge and draw it out to almost razor sharpness. You will be surprised to find how much easier it is to work with a tool sharpened in this manner. This treatment is also excellent for a new spade which, as a rule, is rather dull. When a spade, or any garden tool for that matter, has been used, a few drops of oil will keep it bright and smooth (Fig. 13).

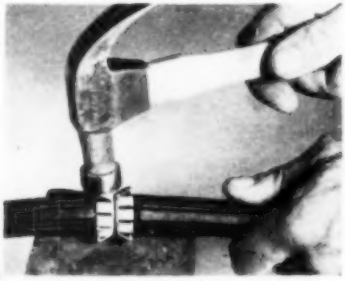


Fig. 10. If a garden hose springs a bad leak, cut out the damaged portion, insert a hose mender, and hammer the prongs down to grip the ends securely

After buying a tool, it is a good idea to rub linseed oil on the handle at once, or, if preferred, give it a coat of shellac.

If your hoe and its handle insist on parting company, a good method of repair is shown in Fig. 11. A cross-shaped piece is cut from tin and folded over the tang of the hoe; then the handle is driven on. A mill file or emery wheel puts a keen edge on a hoe, sickle, and similar tools.

Should your rake have suffered a broken back, a simple repair may be made by punching holes in a strip of sheet iron and fitting it over the teeth (Fig. 12). The sides of the strip are then bent up and over the top and hammered down to fit snugly.

Carefully draining the hose after use and storing it in a dry spot, preferably out of the sun, will delay decay and leaks. If hung over a series of large spikes, driven in a wall to form a semicircle, a hose will not kink or bend. The spikes may be covered with rubber tubing, or dowels or short pieces of broomstick substituted.

Test the hose for leaks by connecting it to a sill cock and closing the nozzle tightly; holes or thin parts can be detected by spurts of water or damp spots. All leaks may then be marked with a colored pencil or crayon. Small leaks can be repaired with shellac and tape. After the hose has dried thoroughly, a coat of gasket shellac should be applied over and around the leak, or thin portion. Next, wind the hose tightly with adhesive tape, using a half-inch overlap. Follow up with a layer of friction tape, and brush a coat of shellac over all.

If the leaks are large, it is better to cut out the broken parts and insert a mender (Fig. 10). These menders may be purchased at hardware stores for a few cents.

Breaks near the nozzle may be due to tugging on the hose. Cutting off the hose and reinstalling the fitting on the fresh end will make it almost as good as new.

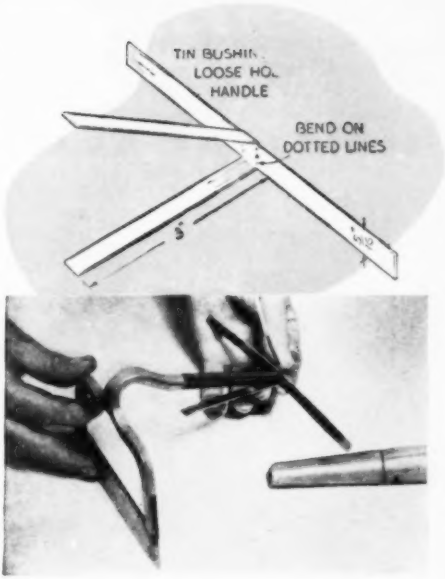
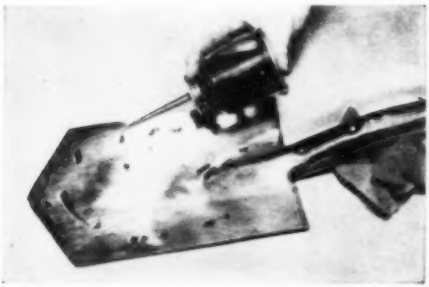



Fig. 11. If a hoe comes loose from its handle, cut a piece of tin to the shape sketched, fold it over the tang of the hoe, and drive on the handle

Fig. 12 (above). A rake with a broken back can be repaired by punching holes in a strip of sheet iron and fitting it over the teeth. The sides are then bent up and over the top, and hammered down. Fig. 13 (below). Tools should be frequently oiled



## How to Remove Printed Labels from Old Metal Containers

EMPTY friction-top cans and various types of commercial metal boxes are used as handy containers in almost every workshop and kitchen. These can be made much more attractive by removing the enameled or painted finish with the printed label and advertising matter. The best way to do this is to use a little paint or varnish remover. The containers may then be left looking bright and new or re-enameled in any color desired. Any necessary lettering can be painted or stenciled on.—J. D.

# IDEAS for HOME OWNERS

**PUTTY IN TAPE FORM.** Puttying greenhouse and hotbed windows is simplified with a sealing compound mounted on a $1\frac{1}{2}$" wide strip of lead foil. After application the foil is left on the putty to protect it from weathering.

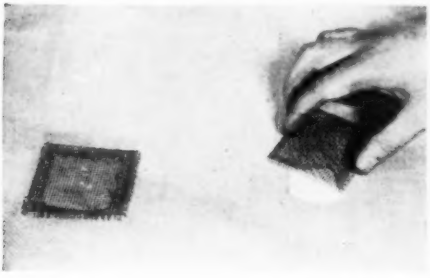
**GLASS-BLOCK FRAMES.** Interlocking metal frames for holding glass blocks in place in walls are now available. They permit easy replacement of broken blocks, and walls made with them can be dismantled, moved to a new location, and rebuilt without damage to any of the materials.

**ALUMINUM INSULATION FOR HOMES.** Thin sheets of aluminum foil have proved effective for insulating walls against heat transmission. Because it reflects radiant heat, this insulation also directs warmth back toward its source. In manufacturing, the sheets are given an irregular surface to decrease contacts between insulation and wall frames.

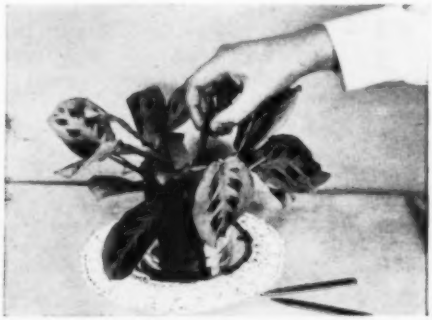
**RULER AND SCALLOP GAUGE.** This 12" ruler has a series of scallops along one edge, ranging in size from 13/32" to 1 3/32". It is useful for laying out scalloped patterns or comparing the size of existing scallops on woodwork or textiles.

**LAWN MOWER CONVERTED TO WEED CUTTER.** Weeds and grass too tall and tough for a lawn mower are quickly disposed of with this device made by Phillip Randall, of Marshfield, Mass. Four razor blades are set horizontally in the circumference of the wooden disk in front of the lawn mower. It is rotated by a belt running to a shaft, which replaces the lawn-mower blades.

**SCREEN PATCHES.** Holes in door and window screens are repaired easily with these patches. Prongs around the edges of the patches are pushed between the wires of the screen to be mended and bent over to hold them in place.



**EASILY INSTALLED DOOR LATCH.** A single hole through a door for the spindle and a notch in the door stop for the catch are all that is necessary to install a latch designed for use on out-swinging screen or storm doors. No mortise is required.



**FOOD STICKS FOR PLANTS.** Wooden sticks saturated with vitamin $B_1$ now provide food for plants. The sticks are inserted in the ground beside the plants. Each time they are watered, a little of the chemical dissolves into the soil.

**COMPACT POWER UNIT.** Sanding, boring, buffing, and polishing are but a few uses of a power unit that weighs less than six pounds. The unit is sold in a metal carrying case with space for accessories. These include a drill chuck, a rubber sanding disk, which can be used on curved surfaces, and a paint stirrer.

# Cruising Sailboat

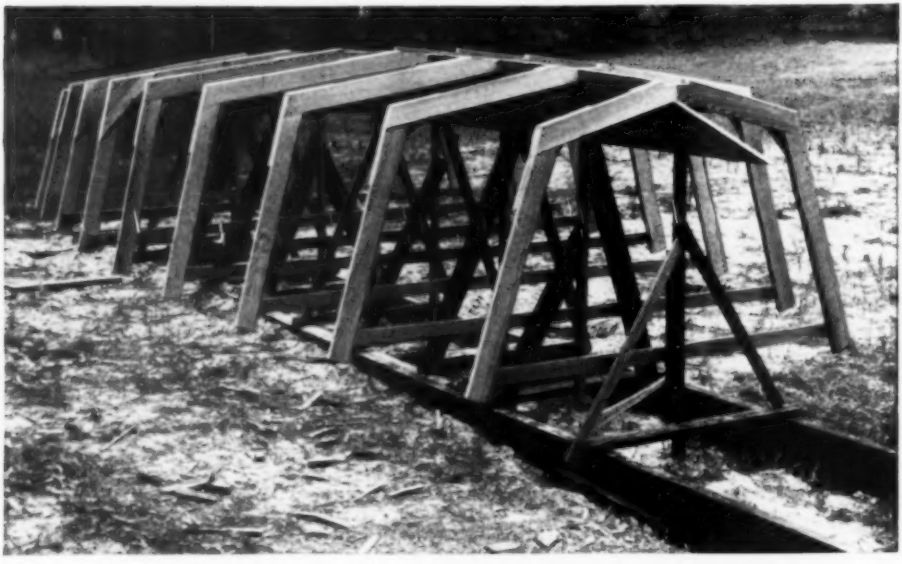
## PART II: SETTING UP THE FRAMEWORK OF "WHITECAP"

**By Bruce and Willard Crandall**

ONCE the frames of our new 19' cruising sailboat *Whitecap* have been cut out and assembled, we can turn our attention to the inside stem—always a tricky part to construct. In this case the design is comparatively simple and should give no great difficulty, even to beginners.

Make the inside stem of three pieces from $2\frac{1}{2}$" or $2\frac{3}{4}$" stock; then check it over the full-size pattern before bolting the parts together as shown in the drawings. Bolt

Left, its perfect balance makes the sailboat fast and easy to handle. Below, frames set up on the keel form



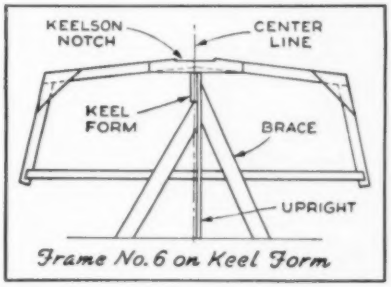
the two parts of the stem to the knee with $5\frac{1}{2}$" carriage bolts. Some extra material should be left on the stem, above the sheer line, to use in fastening the stem down to the floor when the boat is set up.

If it is decided to rabbet the stem instead of using a bent outside stem, the stem should be made $\frac{3}{4}$" larger so as to take the place of the outside stem. In other words, the measurements of the stem are taken from the dotted line shown on the drawings of the stem, but the solid line should be marked on to indicate the rabbet line. Then a hole should be drilled and a softwood plug or stopwater driven through the stem at the intersection of the joining of the two parts and the rabbet line. The exact angles of the rabbet are best determined after the stem and framework are set up.

The hull should be built upside down on a framework supported from the floor or from two timbers, or the framework can be braced to stakes driven in the ground. The essential part of the framework is the keel form on which the keelson, stem, frames, and transom will rest. The keel form is cut from a 1" by 10" by 18' plank according to the measurements given in the drawings. Cut notches where the frames and floor ties will rest. They should be just deep enough so that each keelson notch will be flush with the edge of the keel form. Cut the notches so that frames 1 to 6 will have the floor ties and knees aft of the frames, whereas frames 7 to 10 will have the floor ties and knees forward.

Nail uprights to the keel form at each station and set the form up at a convenient height for working, braced as shown. The uprights must be perfectly plumb and at right angles to the keel form. The frames should be set in the notches and temporarily fastened to the uprights in such a way that their center lines are exactly plumb and at the center of the keel form. The transom and inside stem are also set up in position at this time. Be sure that the stem is perfectly plumb before fastening it in place.

The board from which the keelson should be cut is now bent in position over the frames, and its width marked on it at each station. Then, after brads have been driven at these marks, use a bending batten to aid in drawing the shape of the keelson. The



Frame No. 6 on Keel Form

Before fastening chines, make sure the bottom frames are at right angles to the keel form, and before fastening the sheer battens, see that the side frames are plumb

keel is cut in similar fashion, but is 2" narrower at every point, to allow the garboard planks to lap over the keelson 1". The keelson should be fastened to the floor ties with 2½" No. 12 screws, at least two to each station, and also fastened to the transom frame and stem.

Clamp the keel temporarily in position over the keelson in order to mark the exact extent of the bevel of the keelson. Screw the keel to the frames, stem, and transom frame with 2½" No. 12 screws, and to the keelson with a double row of 1½" No. 8 screws spaced about 6" apart. Be sure no screws are put in where the slot is to be cut for the centerboard.

Before the keel is fastened, the joining surface should be coated with marine glue or paint. It is a good idea to paint all joining surfaces before fastening; and, if the boat is built outdoors, all parts should be painted as the work progresses.

After making sure that the stem is in perfect alignment, that the keel form is straight, and that each frame is at right angles to the keel form, cut the notches for the chines. The chine will be notched into all frames, including the transom frame, but not into the transom planking. Clamp a batten in place before cutting the chine notches, to make sure of getting a fair curve and the proper bevels. Cut the chine pieces down to about ½" where they are to be notched into the inside stem.

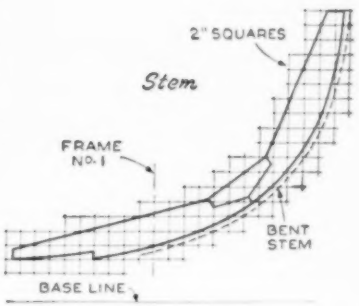
The chines can be fastened with 2" No. 10 screws. It is best to bend both chines into position at once to prevent pulling the stem and framework out of line. Then notch the sheer battens into the frames and fasten with 1½" No. 8 screws.

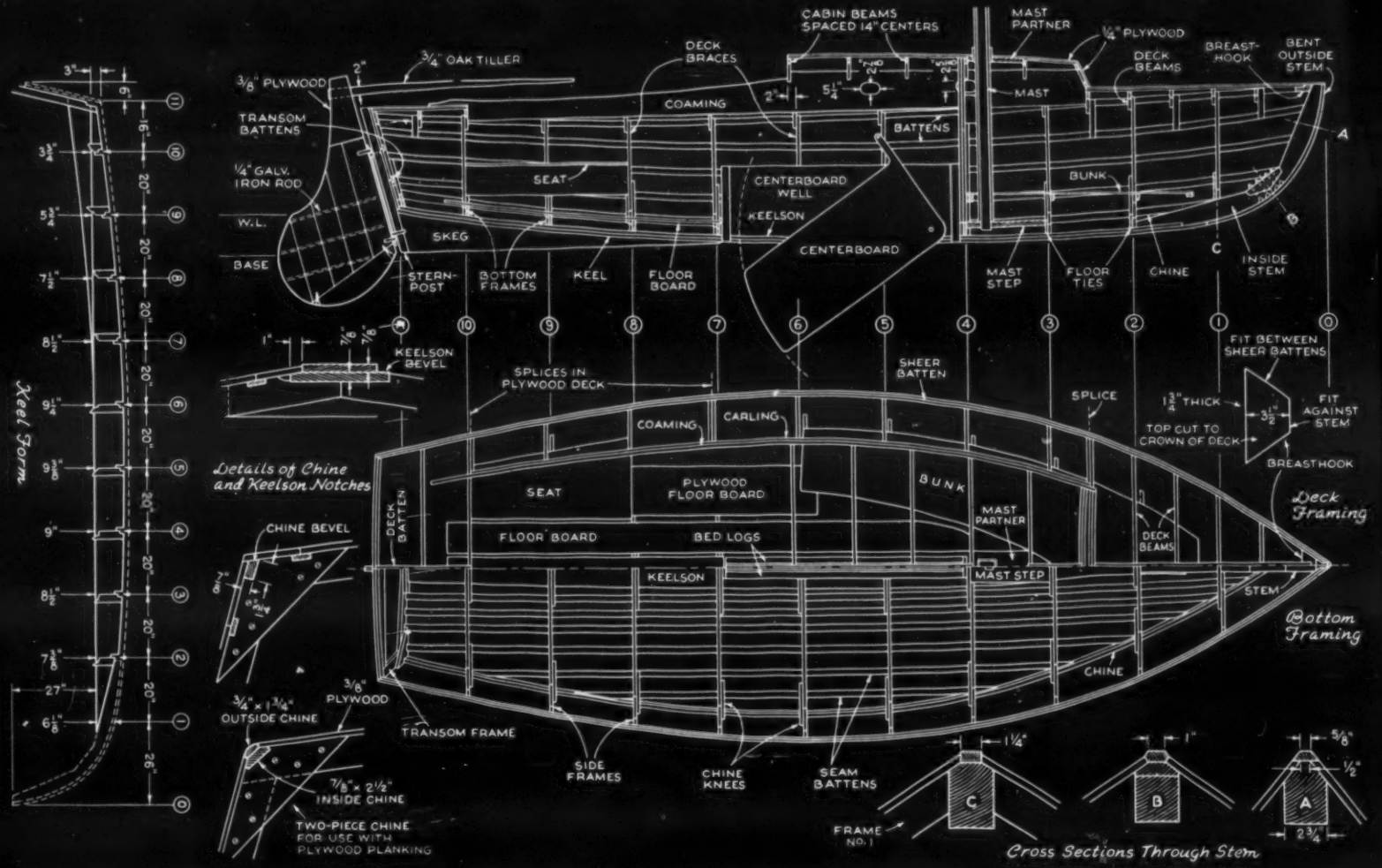
Next, the entire framework should be faired and beveled so that the planking will fit perfectly. The chines, frames, transom, stem, and keelson must be beveled. The inside stem is beveled down to about ½" at the forward face, the amount of bevel gradually lessening toward the point at which the outside stem will meet the keel. A light batten bent over the framework at various points will aid in determining the correct bevels. If clamped in position for the full length of the boat, the batten shows up any unevenness.

(To Be Continued)

Setting up the inside stem (see drawing below and side view of boat on facing page). Take great pains to plumb the stem

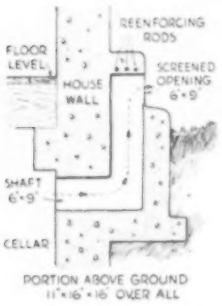
The chines and sheer battens are notched into the frames and stem. It is necessary to cut the chines down to about ½" where they are notched into the inside stem. Note lines on face of stem to show extent to which it will be beveled




Keel Form
3"
9"
18"
20"
11
10
9
8
7
6
5
4
3
2
1
0
3⅜"
5¾"
7½"
8½"
9¼"
9⅞"
9"
8½"
7⅜"
6⅛"
27"
26"
3/8" PLYWOOD
TRANSOM BATTENS
¼" GALV. IRON ROD
W.L.
BASE
SKEG
STERN-POST
BOTTOM FRAMES
KEEL
FLOOR BOARD
¾" OAK TILLER
2"
DECK BRACES
COAMING
CABIN BEAMS SPACED 14" CENTERS
2"
5¼"
SEAT
CENTERBOARD WELL
KEELSON
CENTERBOARD
BATTENS
MAST
MAST PARTNER
¼" PLYWOOD
DECK BEAMS
BREAST-HOOK
BENT OUTSIDE STEM
BUNK
A
B
C
MAST STEP
FLOOR TIES
CHINE
INSIDE STEM
1"
⅞"
⅞"
KEELSON BEVEL
SPLICES IN PLYWOOD DECK
SHEER BATTEN
SPLICE
FIT BETWEEN SHEER BATTENS
1¾" THICK
3½"
FIT AGAINST STEM
TOP CUT TO CROWN OF DECK
BREASTHOOK
Details of Chine and Keelson Notches
CHINE BEVEL
⅞"
0°/24°
COAMING
CARLING
SEAT
PLYWOOD FLOOR BOARD
BUNK
DECK BATTEN
FLOOR BOARD
BED LOGS
KEELSON
MAST PARTNER
MAST STEP
DECK BEAMS
STEM
Deck Framing
Bottom Framing
CHINE
3/8" PLYWOOD
3/4" × 1 3/4" OUTSIDE CHINE
7/8" × 2½" INSIDE CHINE
TWO-PIECE CHINE FOR USE WITH PLYWOOD PLANKING
TRANSOM FRAME
SIDE FRAMES
CHINE KNEES
SEAM BATTENS
FRAME NO. 1
1¼"
1"
⅝"
½"
2¾"
C
B
A
Cross Sections Through Stem

## Ventilator for Deep Cellar Built Like a Periscope

CELLARS of homes built partially into the side of a hill can be ventilated at the deep-set end with the special type ventilator illustrated. Built like a periscope, its exposed horizontal surfaces are formed to shed rain water. The opening, surrounded by an angle-iron frame cast into the concrete, is fitted with a piece of screening. If the cellar is heated during cold weather and no ventilation is desired, the screening can be replaced with a metal plate. A wooden form was used to shape the air shaft and removed by collapsing the pieces after the concrete had set.—J. M.



## Drying Metal Garden Chairs

CERTAIN new-style tubular-frame steel lawn chairs collect little puddles of water after a rain. If a hole about $\frac{1}{8}$" in diameter is drilled in the center of the seat toward the back, the water will drain away and the chair will dry quicker.—E. W. WILLIS.

## Lump of Putty Kept Handy on Bent Piece of Wire

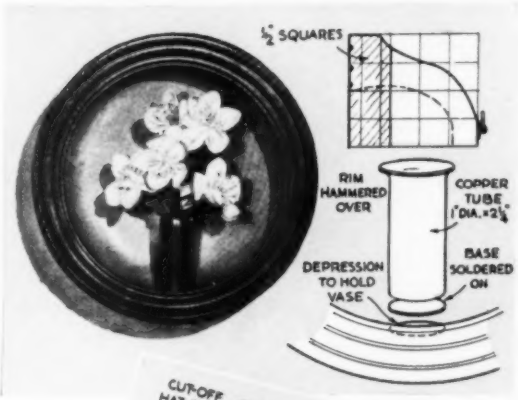
TO KEEP a small lump of putty handy for filling nail holes when painting, one painter bends a length of wire as shown. The putty is pressed around the wire, which is then hooked over the edge of the pail.—G. H.

## Hook Improves Rural Mail Box

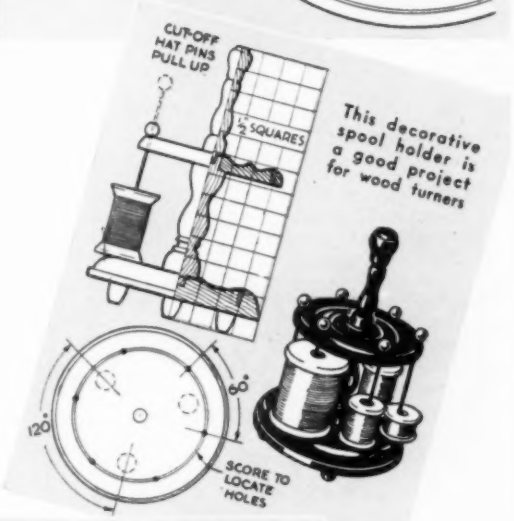
OUR rural mail box was breaking down because the letter carrier hung on it the many heavy packages we received, so I screwed a coat hook on the post.—J. S.

# WORKING TIME: ONE EVENING

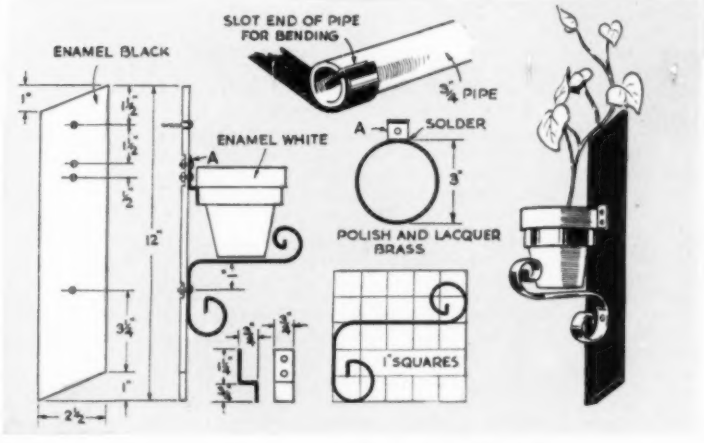
BOWL-LIKE VASE HOLDER. Turn this from glued-up block of ¾" thick dark-colored wood and 1½" thick light-colored wood (such as mahogany and maple) to 8¼" diameter as shown. Cut small flat-bottomed depression in which to stand a small vase. Make vase from a piece of copper tubing 1" in diameter by 2¼" long. Hammer out a flange around the top, and solder in a bottom. Design from Metropolitan Junior Achievement, New York. Craftsman's time, 3 hours; beginner's, 4 hours.



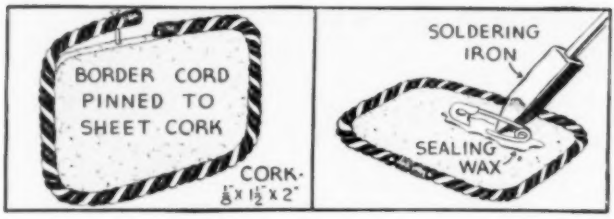

SPOOL HOLDER. Often called a "Salem spool holder," this piece may be turned from mahogany, red gum, maple, walnut, or other cabinet wood. Craftsman's time, 2½ hours; beginner's, 3¾ hours.


CUT-OFF HAT PINS PULL UP
½" SQUARES
This decorative spool holder is a good project for wood turners
60°
120°
SCORE TO LOCATE HOLES

WALL HOLDER FOR IVY POT. Materials: 1 small flowerpot; 3 pc. 18-gauge brass ¾" wide and 2¾", 10", and 14" long respectively; 1 pc. plywood ¼" by 2½" by 12"; 3 roundhead brass machine screws ⅜" by 8/32 with 3 brass nuts; 1 roundhead brass wood screw, 1½" No. 8. Shape, finish, and assemble the parts as shown. The scrolls are bent with the aid of a slotted ¾" iron pipe. Craftsman's time. 1½ hours; beginner's, 2¼ hours.




The back of the ivy-pot holder is plywood enameled black. The brass strips are buffed or polished with steel wool, then lacquered. The flowerpot, if not already painted, should be enameled white




The miniature slate is made of sheet cork and bound around the edges with colored cord. A safety pin is fastened to the back

## Fast-Selling Novelty Name Pins Resemble Schoolboy Slates

NAME pins or brooches are best-sellers in the field of novelty craftwork. I've made many like that illustrated as gifts and sold a number at twenty-five cents each.

I use sheet cork about ⅛" thick, which can usually be obtained from a garage, auto supply store, or stationer's. This is cut up into pieces approximately 1½" by 2". Round the corners and black in the "slate" with India ink.

The border cord is from the ten-cent store and comes in a variety of color combinations. I put it on with pins, first tying an end with thread so it won't unravel. After working it around the "slate," retie the loose end about ⅛" from where it will be cut off. A few drops of sealing wax does the rest, and the wax is then colored to match the cord.

The lettering is done with white poster paint. Any number of effects can be obtained. If a few of the letters are printed backwards, it lends a desirable "schoolboy" touch.

The brass safety pin at the back is put in a depression or slot cut into the cork, and this is filled with gold-colored sealing wax. I find that a soldering iron melts the wax nicely.—BEN ROTTMAN.

### PEWTER

*[METAL ETCHING—5]*

Old-style pewter is difficult to etch because the metal is so soft and porous. The new type of pewter now commonly used for decorative metal working contains a large percentage of block tin and may be successfully etched with commercial nitric acid. This can be used full strength, but if deep etching is to be done add the acid to an equal quantity of water. (CAUTION: Do this very carefully.) Be sure the acid does not come in contact with the hands or clothing.

Clean the surface of the metal thoroughly with a dry abrasive and wipe with a clean cloth. Do not allow fingers to touch the cleaned surface. With a camel's-hair brush and asphaltum varnish, paint evenly all portions of the metal that are to remain unetched. Let this dry thoroughly. Lower the piece carefully into the etching bath and leave long enough to etch to the desired depth.

If a picture, design, or name is to be etched into the metal, paint the entire surface evenly, let dry, then sketch or trace the design on the asphaltum with a soft pencil. Use a sharp scratch awl to cut the lines through to the metal. After etching, remove the asphaltum with kerosene or lacquer thinner, and wash and polish. All the parts that have been etched are left black. In most cases this adds to the effectiveness. The black can be removed, if necessary, by polishing or buffing.

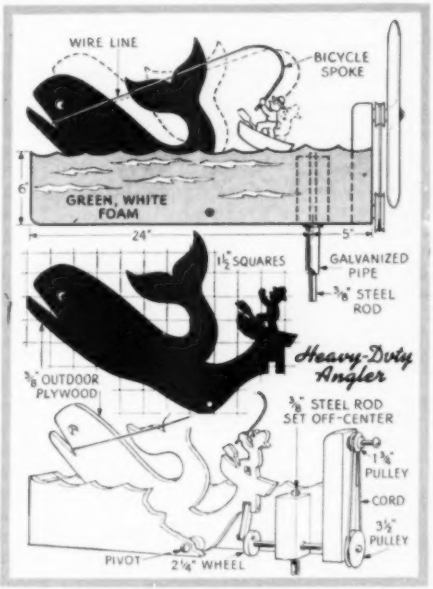
POPULAR SCIENCE MONTHLY SHOP DATA FILE

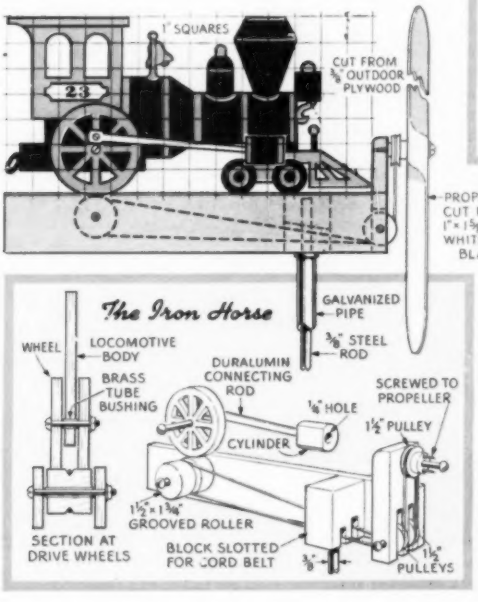
# ANIMATED WINDMILLS

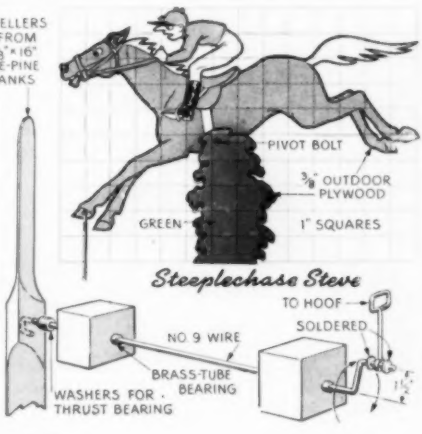
PUTTING the wind to work has always been a lot of fun, so here are three novel animations driven by small windmills. In the first a hopeful fisherman tries everlastingly to land a whale. The cut-outs are of waterproof outdoor plywood and are operated by a connecting rod on a crank disk, as shown. Bearings of brass tubing make for easy running and long life. Note that both spindle and revolving shaft are set off-center to avoid interference. The propellers in this and the other two projects are of conventional two-blade design.

The brightly painted, old-time "iron horse" never gets anywhere, but it runs at full speed whenever the breeze freshens. The drive wheels ride on a roller turned by the propeller through a cord belt. Connecting rods of duralumin (there is one on each side) or other rustproof metal slide back and forth through an oversize hole in each dummy wood cylinder.

Steeplechase Steve consists of a plywood silhouette and a rocking link.



# Rolled-Edge Copper Tray

THIS rolled-edge metal tray can be made of copper to harmonize with maple and other light-toned woods, or of nickel silver or aluminum to accompany dark-toned furniture and accessories. The handles shown were turned from thick-walled black plastic tube, but inexpensive commercial drawer pulls can be used instead. These are available in plastic or metal, either with or without chromium or copper trim. The dimensions of the tray can be altered, if necessary, to suit.

The original was made of a 10½" by 12" sheet of ordinary hard commercial 18-oz. copper (about No. 22 B. & S. gauge). This is thin enough to be rolled over by hand, yet the scrolls provide sufficient rigidity lengthwise. If a bright finish is desired, polish the metal with fine abrasive paper and finish on a buffing wheel. In the absence of a buffing wheel, a pleasing satin finish can be obtained by using powdered pumice stone on a wet rag, but rub only in one direction, lengthwise. It is advisable to give the sheet a preliminary finishing before the scrolls are turned, as it is almost impossible to reach some parts afterwards.

Unless the sheet is annealed along two edges, the end of the scroll may remain somewhat flat. This does not detract from the finished piece, but if a full curve is preferred, the edges can be annealed in the long flame of a gas-oven burner. Heat to redness, and quench in water.

The scrolls are formed around a length of ⅞" hardwood dowel. This is clamped to the sheet with a steel bar about ⅜" square underneath. The steel should have a strip of leather or felt glued to it to prevent marring the work. Use three or four clamps to start the scroll; when partly rolled over, remove the center clamps to finish bending. Buff or rub smooth any marred spots, and give one or two coats of clear lacquer to prevent discoloring.

The handles shown were turned in one piece from a section of rather thick plastic tube and then cut apart. Drill and tap the handles for 6-32 screws.

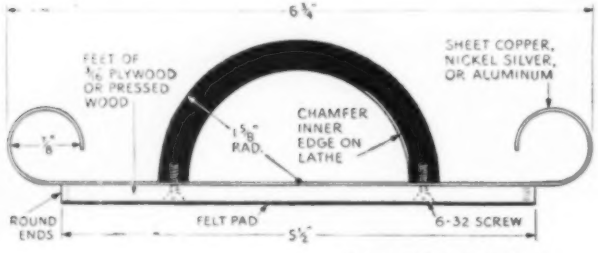
For feet, use 3/16" thick pressed composition wood or plywood. In larger tray sizes, or if the metal does not prove stiff enough to support a load of glasses without bending slightly, omit the feet and substitute a sheet extending the full length. Drill and countersink holes of a clearance size for 6-32 screws, and assemble.

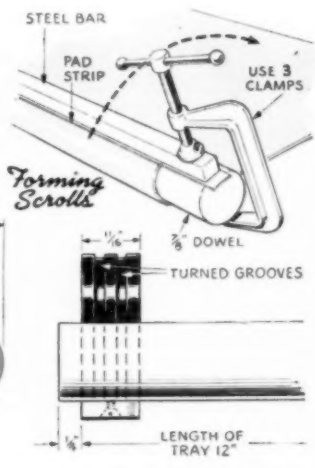
If desired, the center of the tray may be engraved, etched, or decorated with a decalcomania (transfer).—HARRY WALTON.

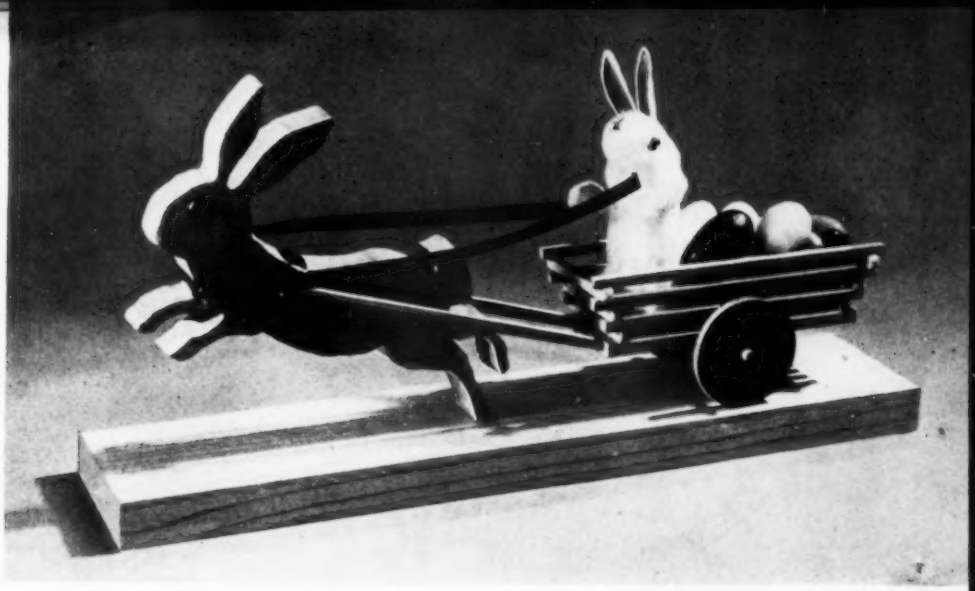
Details of the finished tray. Inexpensive drawer pulls may be substituted for the plastic handles and a sheet of plywood added to stiffen the tray

Clocked Project

*Average Time*
*3½ hours*



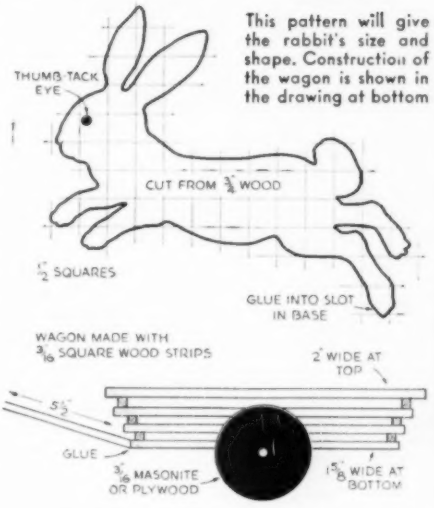


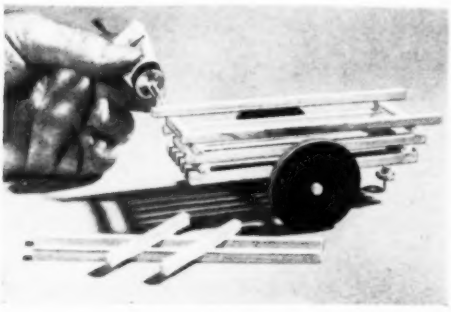
# Bunny Wagon for Easter Table Centerpiece

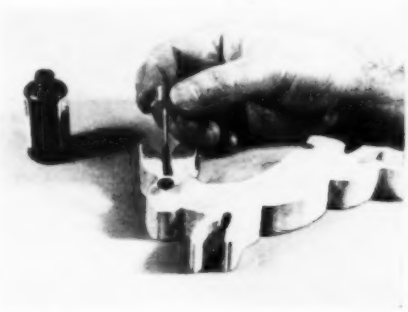
HERE is an easily made centerpiece for the Easter table that will amuse the adults and be admired by the children.

Cut the rabbit from any available $\frac{3}{4}$" wood. Insert nickeled thumb tacks for eyes and paint the center or edges with red or pink nail polish. The base is a 3" by 14" piece of wood with a slot cut $6\frac{1}{4}$" from one end, into which the rabbit's legs are fitted and fastened with cement.

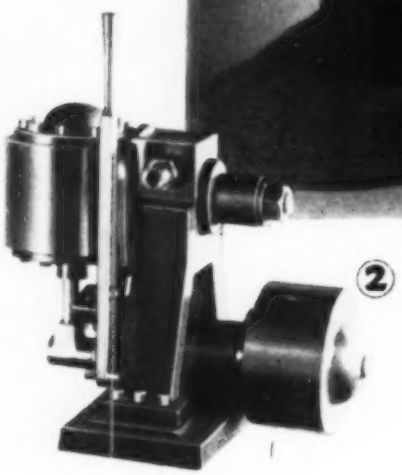
From some 3/16" square strips of wood cut a piece $2\frac{3}{4}$" long and round the ends to make an axle for two $1\frac{3}{4}$" wheels of plywood or pressed wood. Cut six strips $4\frac{3}{4}$" long and cement them, with small spaces between, at right angles to the axle. Cement crosspieces at each end, then add two slightly longer pieces at the sides, and in this way build up the wagon body. Two strips $5\frac{1}{2}$" long attach the rabbit to the wagon. Ribbons for reins and harness and a cotton rabbit for a driver may be added.


This pattern will give the rabbit's size and shape. Construction of the wagon is shown in the drawing at bottom
THUMB TACK EYE
CUT FROM $\frac{3}{4}$ WOOD
$\frac{1}{2}$ SQUARES
GLUE INTO SLOT IN BASE
WAGON MADE WITH $\frac{3}{16}$ SQUARE WOOD STRIPS
2" WIDE AT TOP
5½"
GLUE
$\frac{3}{16}$ MASONITE OR PLYWOOD
1⅝" WIDE AT BOTTOM





For anyone who owns or has access to a small metal - turning lathe, a model engine is a fascinating project




# OSCILLATING STEAM ENGINE

## *with Reverse Gear*

By C. W. WOODSON

HERE is a single-acting model engine of the oscillating type (Figs. 1 and 2) that was designed especially for model makers who have been looking for a not-too-complicated project. It is the simplest form of steam engine—and perhaps the easiest of all to build. Simple as it is, however, it needs care and accurate work throughout, especially in laying out the steam ports.

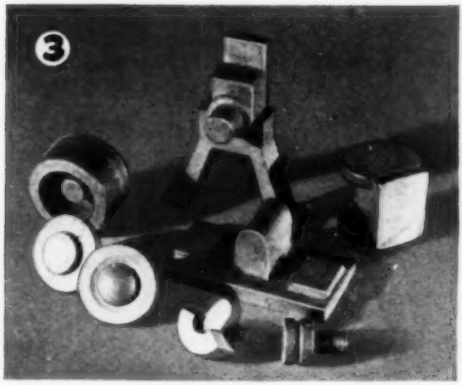
Model makers can have a lot of real enjoyment by drawing the port faces on paper and making an overlay of the reverse ports on tracing cloth. Stick a pin through these drawings at the pivot point to enable them to be moved back and forth. This will clearly show how the engine works and also aid in its construction.

With the exception of a leakproof piston, the most important essential in constructing an oscillating engine is to have steam-tight port faces. Even though great care is used in machining these port faces, it is best to finish-grind them together with fine valve-grinding compound, which will make a steam-tight joint and insure the snappy performance of the little "wabbler."

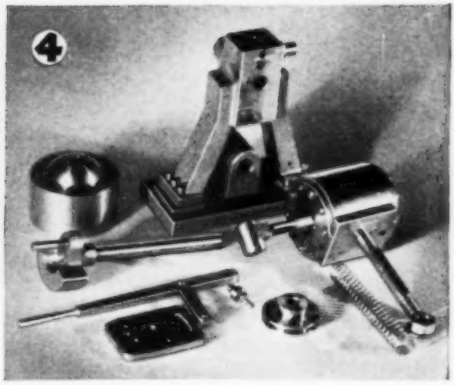
There are two ways to approach a model-building problem such as this engine. One is to purchase a set of castings or a construction kit and devote one's time exclusively to machining and assembling the parts. The other is the method of the inveterate model maker who wants to do every part of the work for himself, beginning with the wood patterns. This method also appeals to the shop departments of high and vocational schools, because a number of sets of castings can then be made from the one set of patterns.

Those who wish to make their own patterns can follow the accompanying drawings if an allowance of about 3/32" is added to the parts where they are to be machined. The detail drawings are half size, and the assembly drawings have a scale. The sharp inside corners of the patterns should be rounded out with a fillet of beeswax, and the well-sanded work given several coats of hard-drying shellac.

The castings can be made at a local foundry or, if you have the facilities, you



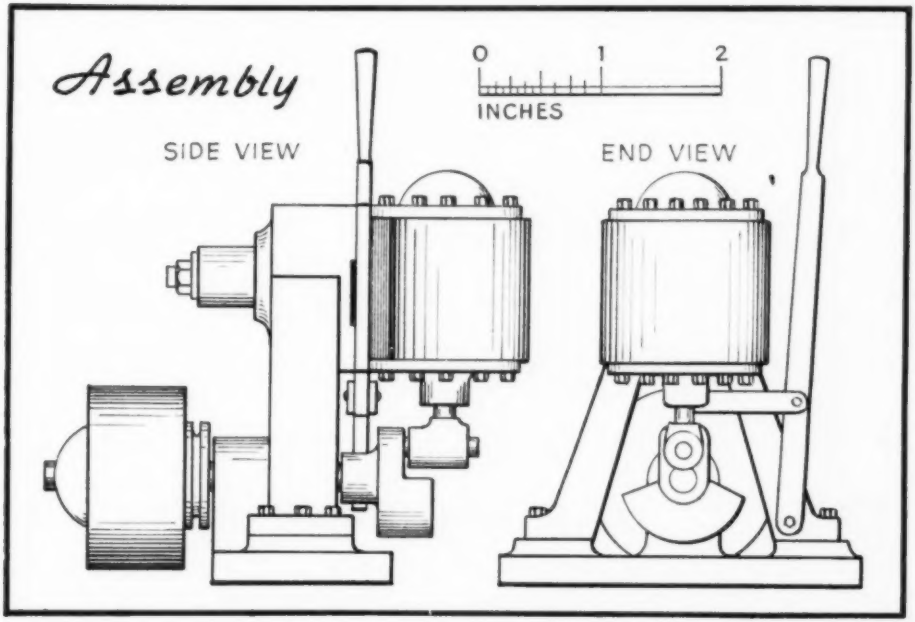

Bronze castings from which the little "wabbler" is built. The only parts not bronze are the crankshaft, piston rod, reverse lever, and coil spring

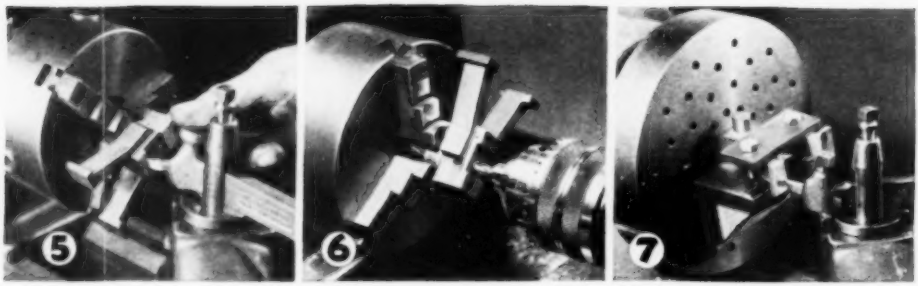



The fully machined parts ready for final assembly. Compare with the assembly drawings below, which show the engine approximately three-quarters size

can pour your own. This can be done in the home shop because the entire engine is made of bronze with the exception of the crankshaft, piston rod, reverse lever, and steel coil spring.

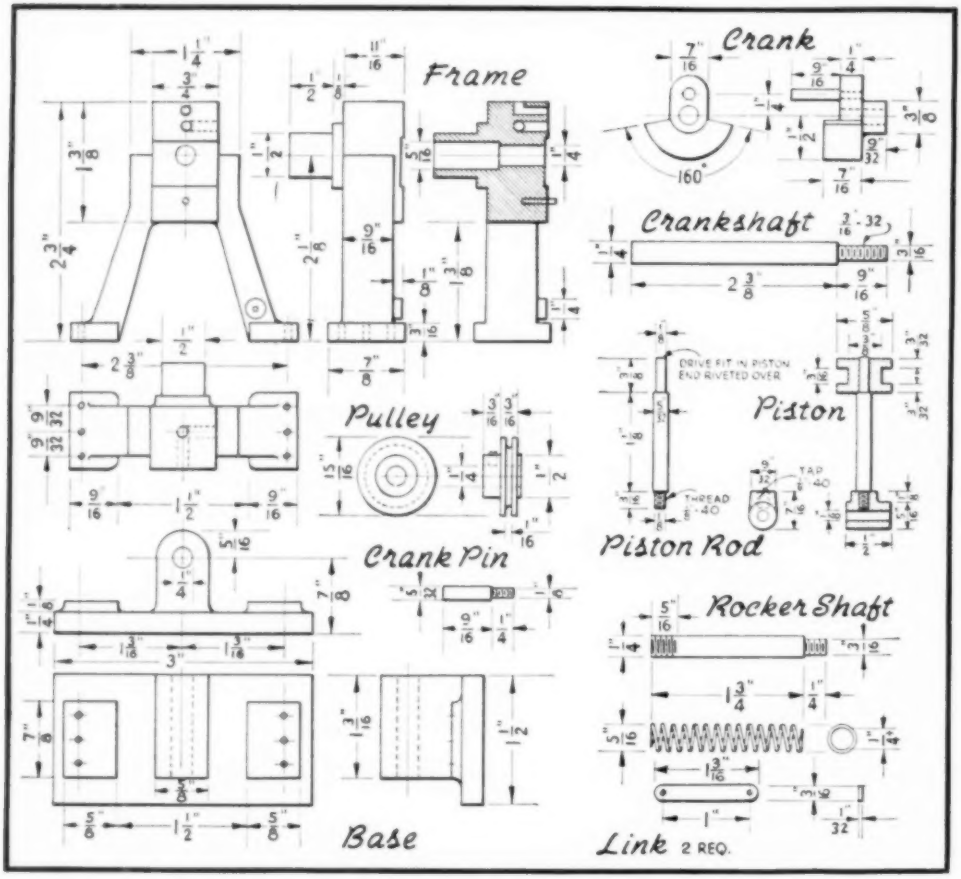
A set of the bronze castings made up to the dimensions in the drawings is shown in the rough in Fig. 3, and the same set with the machine work finished in Fig. 4. With these castings on hand, work can be started. Perhaps the best place is on the casting for the frame, as this is the main part of the engine and will need to have a number of other parts fastened to it. The photo, Fig. 5, illustrates how the casting is securely held in the three-jaw chuck by the cylinder pivot bearing. This allows the port face to be machined smooth and true,

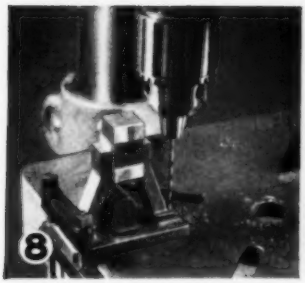


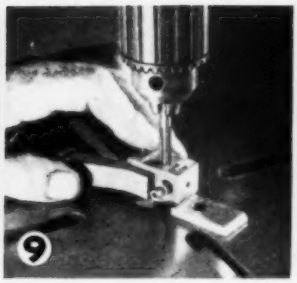


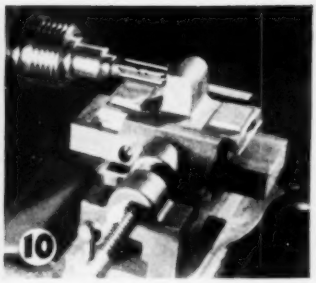

which is done with several light cuts and very fine feed.

The pivot hole should be drilled (Fig. 6) at this same chucking as the hole must be accurately at right angles to the port face. The feet or bottom of the frame can be turned smooth and square with the face by bolting it to an angle plate as in Fig. 7. The screw holes for fastening the frame to the base are drilled while the two parts are clamped securely together as in Fig. 8. The reaming of the pivot hole is shown in Fig. 9, although this could be better done in the lathe when the hole is drilled. The casting can be smoothed up with a fine file, and work started on other parts.



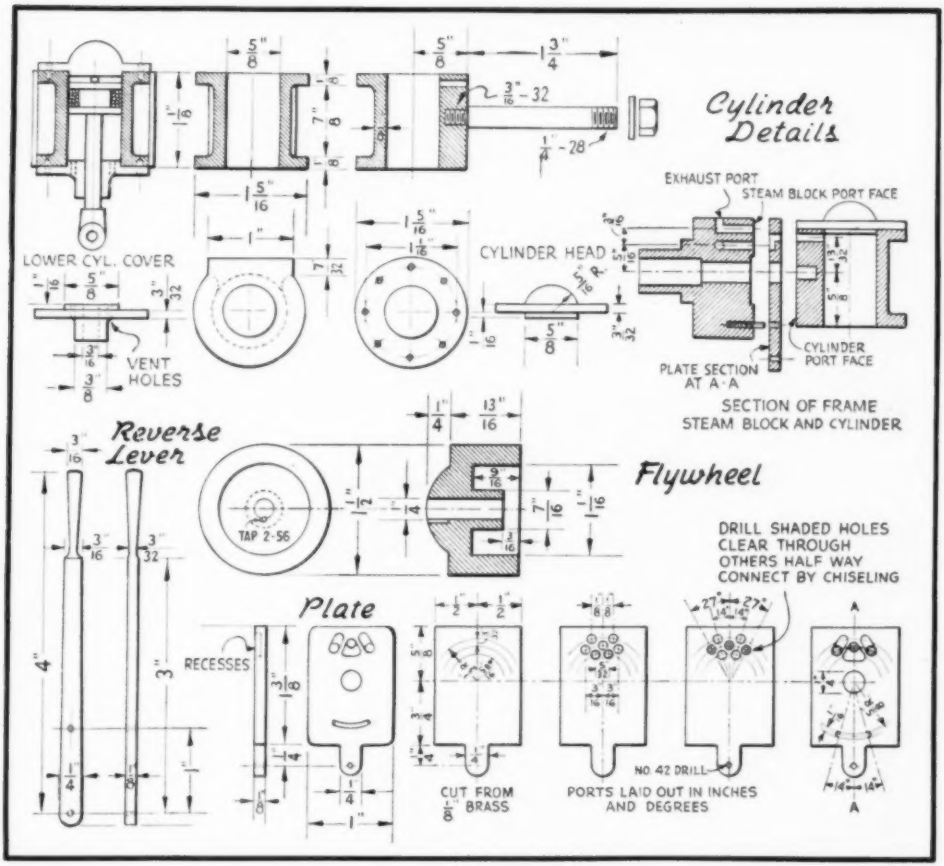


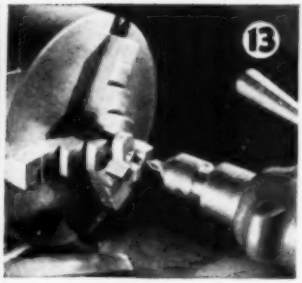




The base casting, being smooth on the bottom, needs no machine work other than a light going over with a file. This allows it to be mounted squarely in the cross-slide vise as in Fig. 10 while the two flats are milled to receive the feet of the frame. After the crankshaft hole has been drilled, it is reamed to the finish size (Fig. 11).

Figures 12 and 13 show operations in machining the crankshaft. The cylinder casting, while being machined, is held in the three-jaw chuck as in Fig. 14. Here the ends are faced and the cylinder bore brought to finished size. The port faces can be machined by clamping the cylinder to an angle plate, or it can be held in the





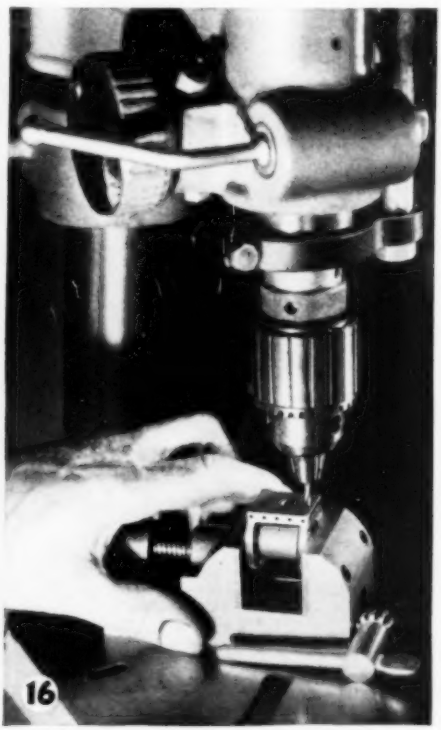

four-jaw chuck, face out, and finished smooth with several light cuts. Use a very fine feed.

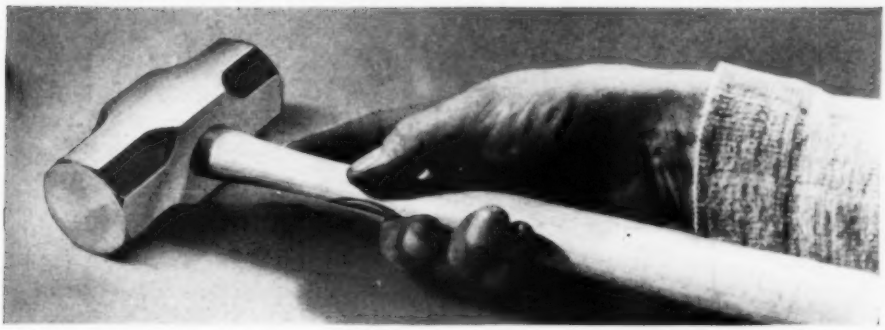
Figure 15 shows the method of fastening the cylinder head to the cylinder. A No. 50 drill is used for these holes, which are drilled through the head and into the cylinder at the same time. The holes in the cylinder are tapped 2-56, while those in the head are opened out with a No. 42 drill to clear the screws. Three of these screws would be sufficient to hold the head in place, but a larger number enhance the appearance.

In Fig. 16 the steam port in the cylinder is being drilled. The dimensions for the ports for both the frame and the cylinder are shown in the sectional drawing along with the reverse plate. Great care should be taken in laying out these holes.

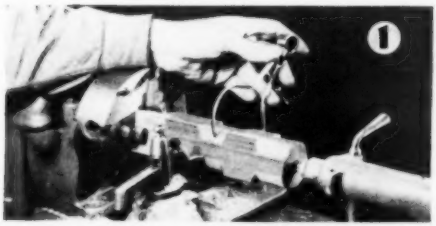
A row of holes may be drilled for fastening the cylinder lagging. In this case, however, a piece of chrome-plated brass tubing happened to be on hand, so it was split and a section cut out just large enough to make a tight drive fit over the cylinder flanges. This bit of bright chrome adds an attractive touch. It had been originally planned to use a piece of light sheet brass fastened with small flathead screws.

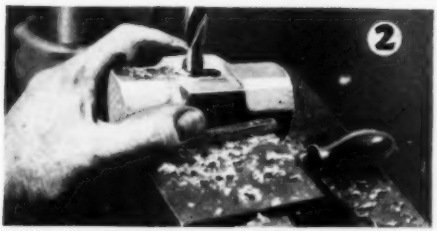
(To Be Concluded)





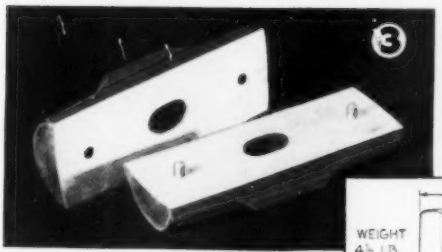
## Bronze Hammer Prevents Marring Finished Work

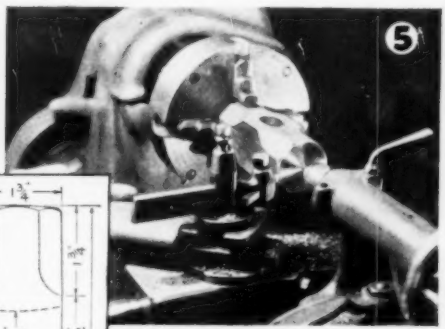


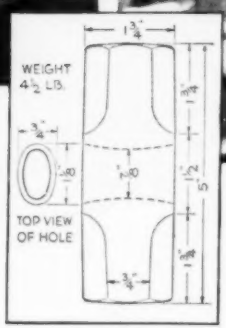




ALTHOUGH a bronze hammer is softer than steel, it is considerably harder than lead and will find much use around a busy shop on work that must not be marred. The hammer illustrated was cast in bronze from a pattern turned in the lathe as in Fig. 1. This was a split pattern made of two pieces of cherry, screwed together and turned as one. The handle hole was drilled from both sides at an angle as in Fig. 2, and Fig. 3 shows the split pattern with the dowels for aligning the two parts. The complete pattern was well sanded and shellacked, and the rough casting appeared as in Fig. 4 when it came from the foundry.

A light center-punch mark was made in the center of each end for tailstock support, and the casting was chucked as in Fig. 5, faced with a number of light cuts, and chamfered. The sides were then draw-filed bright and a handle inserted.—C. W.



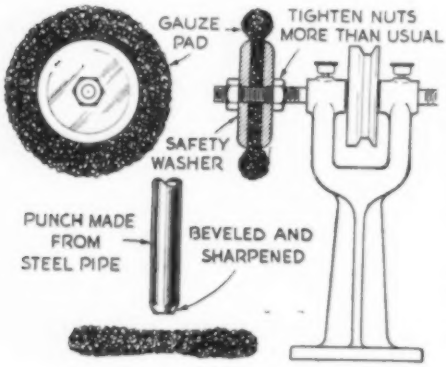



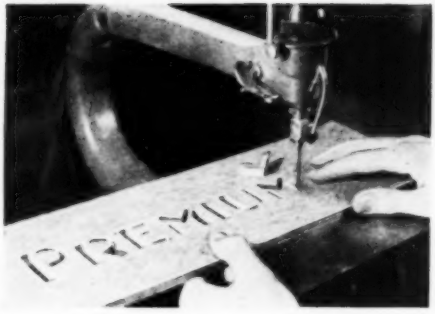



Making a bronze hammer is an instructive project. The pattern is prepared as in Figs. 1 to 3, the casting appears as in Fig. 4, and the machining is done as in Fig. 5

## Copper-Gauze Pad Polishes Parts Made of Soft Metal

IF YOU have no soft brass scratch brush for cleaning and polishing aluminum, brass, or other soft metal, you can make an excellent substitute from a ten-cent copper-gauze kitchen cleaning pad. Punch a hole $\frac{1}{2}$" in diameter through the exact center of the pad with a steel pipe, the end of which has been sharpened, and mount it on the shaft or mandrel. Use large retaining or safety washers and tighten the nuts on each side securely. When using this pad in the lathe, run the machine at a low speed. The writer uses a pad like this to polish aluminum-alloy pistons and finds that it does excellent work without scratching the surface as a steel-wire brush would do.




## Patterns and Border Stencils Cut Out on the Jig Saw

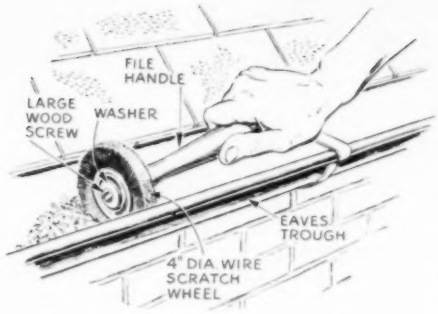
WHEN it is necessary to cut several identical stencils or patterns, tack the required number of sheets of stencil paper to a sheet of thin plywood and cut them out on the jig saw. The outlines may be sketched or painted on card or paper stock, which is much easier to work on than the oiled stencil paper. This sheet is then placed on top of the pad. A hole is drilled for the start of each inside cut, and a medium fine jeweler's blade should be used for smooth accurate work.

If decorative border stencils are to be used, it is especially convenient to make extra pieces in this way for a change of color and also to replace those worn out by being bent around corners or over uneven surfaces.—L. L.

## DRAW-IN COLLET ATTACHMENT [*LATHE WORK—9*]

The collet chuck—most accurate of all chucks—is used for precision work. Long or short rods can be held in the chuck for machining. The diameter of the work may vary 0.001" smaller or larger than the collet-hole size, but the greatest accuracy and precision are obtained when the diameter of the work is exactly the same as the collet hole. To avoid distortion, a collet should never be closed without a suitable piece of stock in the hole.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

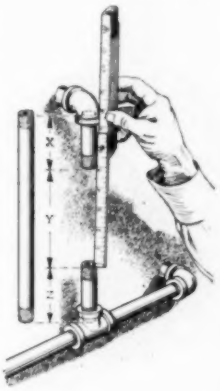


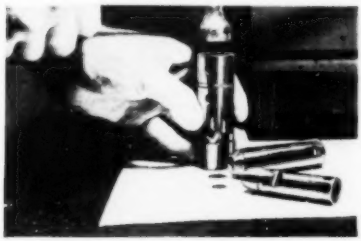

## Curved Scratch Brush Cleans Metal Valleys and Gutters

FOR cleaning sheet-metal valleys and gutters preparatory to soldering or painting, one mechanic uses a special curved brush formed by fastening a discarded circular scratch brush 4" in diameter to an old file handle with a large wood screw and washer.

## Foolproof Way of Measuring Pipe Lengths Accurately

WHEN pipe must be fitted to pass through specified holes in walls and conform to definite layouts, the amateur mechanic can make accurate measurements with the aid of a couple of short pipe nipples, as shown. The nipples, though inserted in place only temporarily, should nevertheless be screwed in tight. Their combined length ($x$ and $z$), plus the distance between them ($y$), will then equal the length to which the required piece of pipe must be cut.



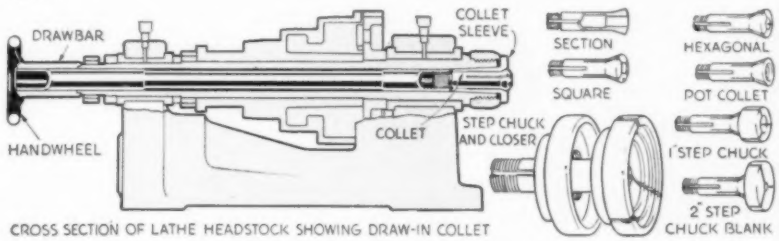



## Punches Ground from Wrist Pins

HOLLOW punches suitable for punching paper, leather, gasket material, lead, and even thin sheet metal may be had in a wide variety of sizes by utilizing discarded wrist pins. Simply grind one end on a taper to a thin cutting edge. A wrist pin from an outboard motor, when ground, will cut a hole about $\frac{1}{8}$" in diameter, while a pin from a large truck motor will often be 2" or better.—J. D.

## COLLETS AND STEP CHUCKS [*LATHE WORK—10*]

Step chucks are used for rapid, accurate chucking of circular disks and other parts requiring but a short grip. They operate on the same radial compression principle as the draw-in collet. The chucks are usually made of cast iron, and the steps are turned to the exact diameter of the work while in place on the lathe, the chuck being compressed onto shims fitting in the saw slots. By suitable recessing of the chuck body, irregular shapes may be held as well as circular work. Step chucks over 2" in diameter are held by a tapered closing ring mounted on the lathe spindle.



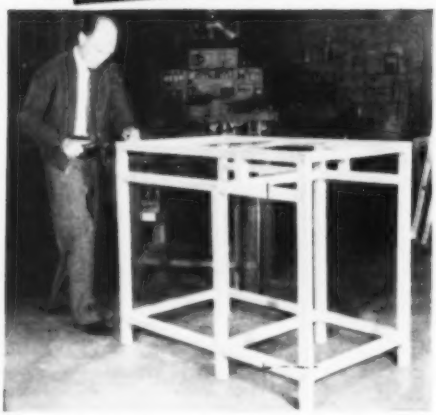

CROSS SECTION OF LATHE HEADSTOCK SHOWING DRAW-IN COLLET

POPULAR SCIENCE MONTHLY SHOP DATA FILE

# SIGN PAINTER'S WORKTABLE

**UNIQUE OUTFIT KEEPS SUPPLIES READY FOR USE**

By LOUIS A. LEMBACH



Assembling the framework with 2 by 2's. Plywood panels are nailed to the inside edges. The design can be altered, of course, to suit individual needs

SIGN painters can save time in their work and keep their shops much neater by constructing a table and storage cabinet like that illustrated. The drawing board, 48" by 48", may be tilted and locked at any angle, and the table contains 83 square feet of drawer and shelf room so divided as to keep all materials handy and in good condition.

The main frame of the table is built of 2" by 2" stock with veneer panels nailed to the inside edges.

The large pressed composition wood drawing board is reënforced around the edge and underneath by strips of 1" by 2" wood. The surface is lined with white lettering ink, then varnished. Mounted on L-shaped hardwood supports, the drawing board is pivoted on bolts, 5" below the top of the table as shown, so that it remains at the proper height no matter how it is tilted.

Storage space for full-size sheets of card-

The large drawing board swings up to reveal a desk top beneath, and can be locked in any position. On the side is a small hinged drawing board 18" by 24"

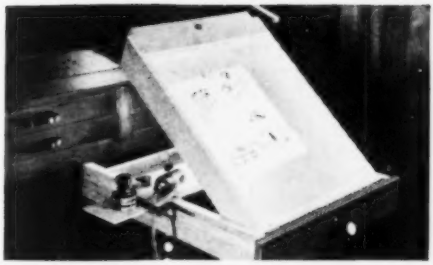
Back view of cabinet. Drawers and shelves hold cardboard, mats, and show-card colors. Note the compartment for banner-paper and sign-cloth rolls

board, 28″ by 44″, is provided under the drawing board, as well as some shelf room. This upper section may be unscrewed so the table can be carried through doorways.

Twenty individual drawers and sliding shelves on both sides of the table provide room for cardboard up to 22″ by 28″. Three drawers at the front of the table each contain a tray and are divided to store pencils and water- and oil-color brushes. The front of the working tray at top right is hinged to hold two small bottles, a removable glass slab, and a divided china slant. Directly under this the frosted glass palette is hinged so it may be tipped up on the drawing board to be used as a tracing glass.

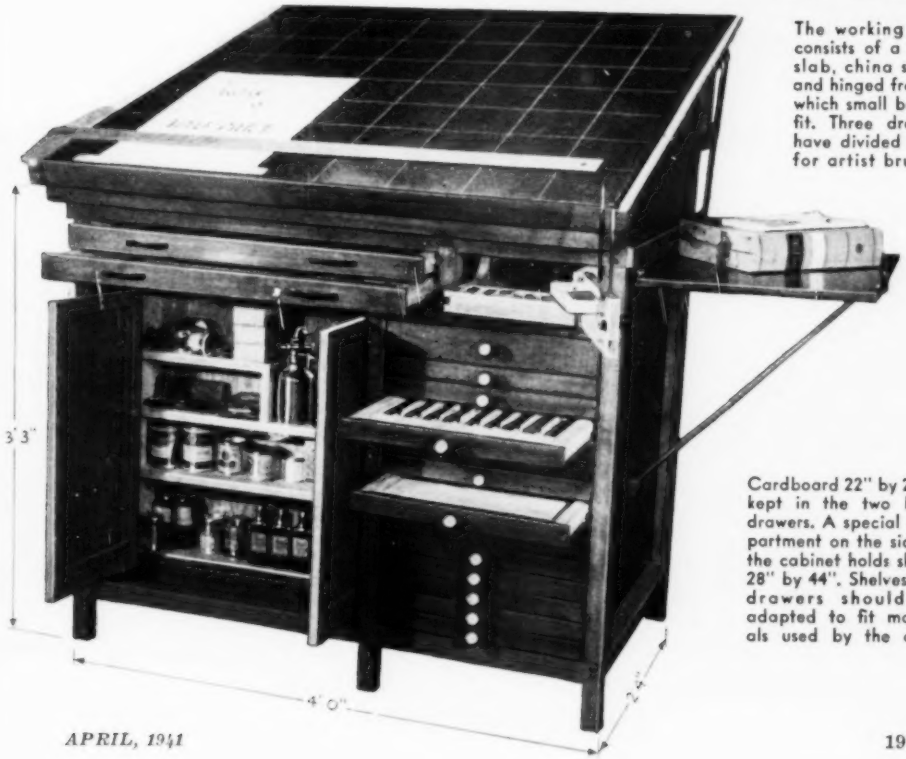
Most of the drawer pulls are salvaged reed-organ stops, and all are labeled. The blade of the T-square is also novel because it contains a series of ⅛″ slots, which are quite handy in marking guide lines.

The materials used, in addition to the large drawing board, were one small drawing board of 3 square feet; 85 square feet of ¼″ pressed composition wood for drawer bottoms; 35 square feet of ¼″ three-ply fir panels; 50 square feet of 1″ pine for drawers and frame; and 60 lineal feet of 2″ by 2″ wood for the framework.



One of the drawers contains a frosted-glass palette which can be tilted up and an electric light placed behind for tracing designs

The working tray consists of a glass slab, china slant, and hinged front in which small bottles fit. Three drawers have divided trays for artist brushes

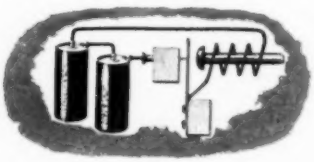



Cardboard 22" by 28" is kept in the two large drawers. A special compartment on the side of the cabinet holds sheets 28" by 44". Shelves and drawers should be adapted to fit materials used by the artist

# Science Stunts

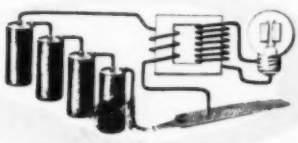
IN THESE modern days, it's surprising how few people understand the workings of electricity. Mysterious it may be—but no more so than gravity. Just as everything that goes up must come down so an electric circuit must carry "juice" to its work and then back again. You might compare the connecting wires to busses (and electricians sometimes call them just that) which transport workers to a factory, and bring them home when their shift is done. According to the kind of shop where they are employed, the electrical workmen—or electrons, if you choose — manufacture light, heat, or sound, or perform plain physical labor. In the five entertaining experiments which follow, you can see how they do familiar tasks in a buzzer or electric bell; in a thermostat that turns your household heat on and off; in fuses that safeguard your home; in a transformer that operates a doorbell or runs Junior's electric train; and in a telephone transmitter or radio microphone. Easily made at home, these simple models give an insight into principles that may be applied to good advantage by the handy man around the house, in repairing electrical appliances and keeping them working efficiently.

**BUZZER.** Assemble, as shown, a bolt wound with bell wire, a strip cut from a tin can, and a wood screw. The adjustable screw should just touch the strip. Current from a pair of dry cells makes the bolt a magnet, and draws the strip toward it. This breaks the circuit, and the flexible strip springs back. Electric bells simply add, to the vibrating armature of tin, a clapper that strikes a gong.



**THERMOSTAT.** This important-sounding instrument is nothing more than a temperature-controlled electric switch. To make one, bolt a strip of iron to a strip of copper or brass, and mount it securely at one end. Apply heat, as with the electric heating element used at left, and the built-up bar bends toward one side. This is due to unequal expansion of the two metals. For the same reason, the bar will bend in the opposite direction when chilled. Electrical contact points may be arranged so as to complete a circuit when the bar moves far enough either way.

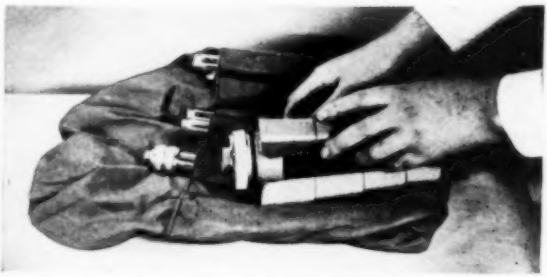
**WHAT FUSES ARE FOR.** If you follow the dangerous practice of replacing a burned-out fuse with a penny, you may get away with it—or your house may burn down. Fuses are "weak links" placed in a circuit to shut off the electricity in case of trouble. Touch wires from several dry cells to a very slender strip of metal foil, and it will melt with a puff, just as a fuse will when the electric wiring is overloaded. Connect the wires directly, omitting the fuse, and a thermometer will show their rise in temperature—perhaps enough to burn the insulation. Similarly, if there were no fuse, short-circuited household wires might soon get hot enough to start a fire.



**TRANSFORMER.** A doorbell transformer lowers household voltage—about 115 volts—to six volts. To show it will work in reverse, connect four dry cells to the low-voltage side. This circuit should be broken, and one loose end connected to a file. Draw the other loose end across the surface of the file. The interrupted six-volt current on one side of the transformer will light a neon lamp attached to the other side.

**TELEPHONE TRANSMITTER.** Lay a pencil lead across the edges of two razor blades connected to dry cells and earphones as shown. Any slight vibration—the ticking of a watch, or passage of breath across the lead—gives a thunderous response in the headset, by changing the electrical resistance of the lead (really carbon) at its contacts with the blades. Similarly, in telephone transmitters and microphones, the voice compresses and loosens carbon granules.

# New Ideas



Folded up in its case, the mike stand occupies little room

## Folding Mike Stand Saves Space

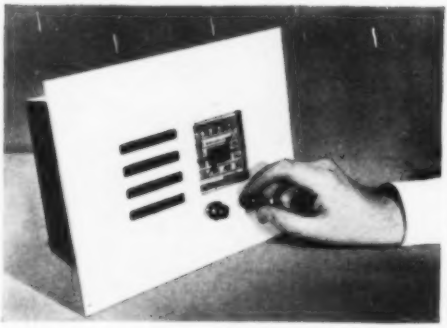
DESIGNED to fit in the carrying cases of most portable public-address systems, a new microphone stand has a telescoping central standard which attaches to a folding base. In its own carrying case, it occupies a space only 13" by 4½" in diameter. Set up, it is adjustable from 16" to 60" in height.

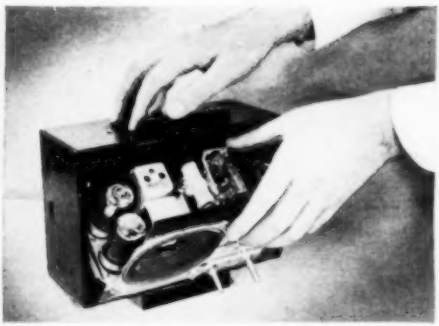
## Midget A.C., D.C., or Battery Set

A COMPACT portable radio of the "camera" type is now offered which operates on direct or alternating house current as well as on its own self-contained battery supply. The power selecting switch and tuning and volume controls are conveniently set in the front panel.

## Radio Designed To Be Set in Wall

SET in the wall of a room like a light switch, a radio receiver just marketed is available with a flush-type panel in several colors to conform with the color scheme of your interior decorations. Mounted in a steel box 3⅞" by 8¾" by 11¼", the radio fits between wall studs and is connected directly to the house wiring.





You can get a panel to match your decorations for this receiver to be set right into the wall of a room

# for Radio Fans

## New FM Adapter for Conventional Receivers

BUILT in an attractive walnut cabinet, a frequency-modulation adapter which connects directly to conventional amplitude-modulation receivers has its own tuning condensers and a dial calibrated in frequencies now being used by FM. With it, the user has the choice of programs broadcast on either type of wave, reception of FM programs being routed through the loudspeaker of the conventional radio.

The adapter has its own tuning controls for getting FM programs

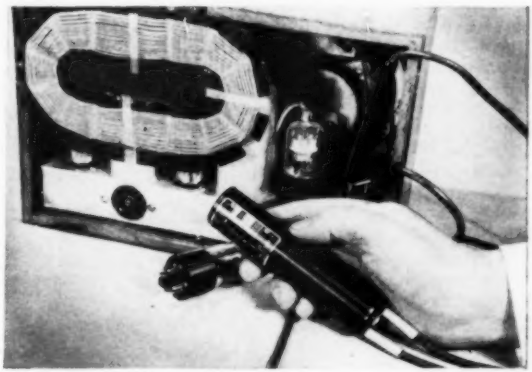
The attractive triple-duty unit weighs less than 20 pounds

## Single Outfit Is Radio, Phonograph, Recorder

A COMBINATION radio, phonograph, and recorder, of light weight and small size, has been offered at a cost comparable with that of many small receivers. The outfit contains its own loop antenna and will record radio programs directly, or home talent through its own hand microphone. The turntable takes records up to 12″ in diameter, and cuts home recordings at the standard rate, 78 revolutions a minute. It weighs less than 20 pounds with its snap-on lid and strong carrying handle.

## Cylindrical Voltmeter Is Convenient To Use

PARTICULARLY handy to use, a new cylindrical voltage tester only 5″ long indicates voltage by the position of a pointer in relation to a graduated scale on one side. Different-colored bands identify each A.C. voltage, 110, 220, 440, and 550. Alternating current vibrates the pointer and reveals the frequency. Rubber-covered leads 25′ long are fitted with hooks and sharp points for piercing insulation without damaging it.



How the electric speaker set fits conveniently on the head of a bed

# BED RADIO

By ARTHUR C. MILLER

CONVENIENTLY hung over the back of a bed, this small radio will bring programs within easy control of late night readers or convalescents. The cabinet and chassis layout have been carefully planned in order to compress the complete set in as small a space as possible without loss of efficiency.

Measuring 7½" square, and with a depth of only 2¾", the cabinet houses a powerful tuned-radio-frequency receiver with a radio-frequency detector, and audio and rectifier stages. Yet only two tubes are used—an important factor in reducing the overall size. One tube, the 12B8GT, contains an RF pentode and high-mu triode, which are used for the RF and detector stages, respectively. The other tube, the 25A7GT, contains the pentode output amplifier and the half-wave rectifier.

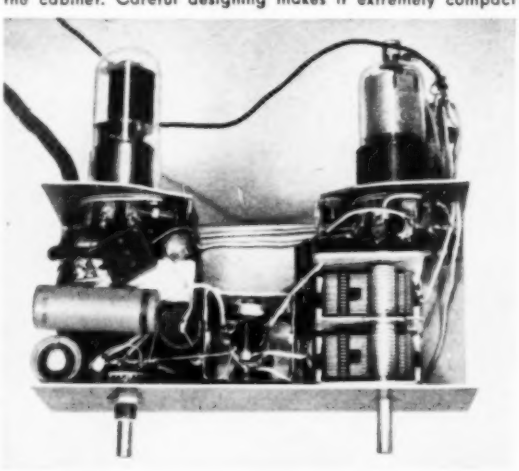
Instead of these tube types, the reader may use the newer low-drain models, the 25B8GT and the 70L7GT. If these tubes are used, the line-cord resistor will have to be changed to one having a built-in resistance of 135 ohms instead of 220 ohms. Also, the connections to the 70L7GT tube differ slightly. Connections to the 25B8GT are similar to those of the 12B8GT. No other changes are necessary in the circuit.

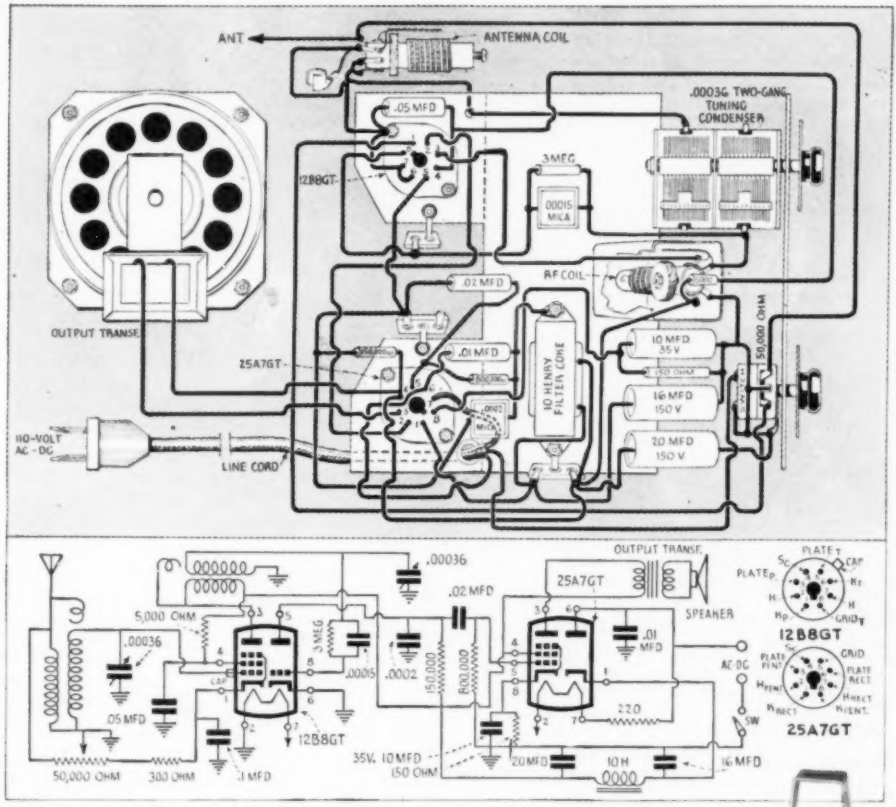
A compact two-gang variable condenser tunes the antenna and the RF coils. The antenna coil is unshielded, and is mounted right next to the 12B8GT tube. The RF coil, though shielded, is mounted in an unconventional way — upside down. However, it is still thoroughly shielded and in this new position makes the wiring of the set a lot easier. The small screw on top of the can, which holds the coil in place, is unscrewed and passed through a hole in the chassis to anchor the shielding can and coil securely in place.

Volume is controlled in the conventional manner, by varying the grid bias on the RF tube, using a 50,000-ohm potentiometer between the antenna and cathode of the RF pentode. A 300-ohm, ½-watt fixed resistor in series with the potentiometer keeps the tube always slightly biased. Ganged with the 50,000-ohm volume control is the S.-P., S.-T. on-and-off switch. To provide greater stability in the RF stage, the screen of the pentode (12B8GT) is decoupled by means of the 5,000-ohm, ½-watt resistor and the .05-mfd. tubular by-pass condenser.

The cabinet is constructed of pine, with

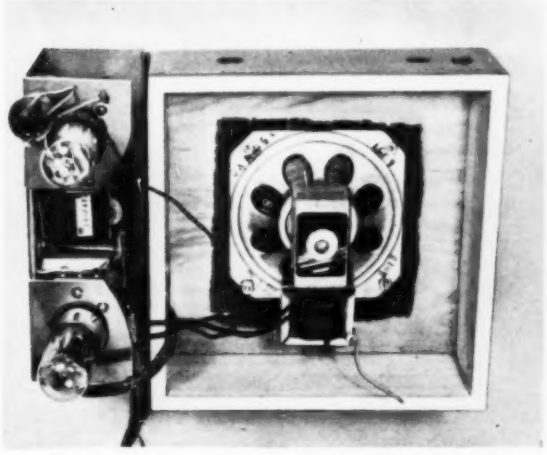
The wired chassis looks like this before being placed in the cabinet. Careful designing makes it extremely compact





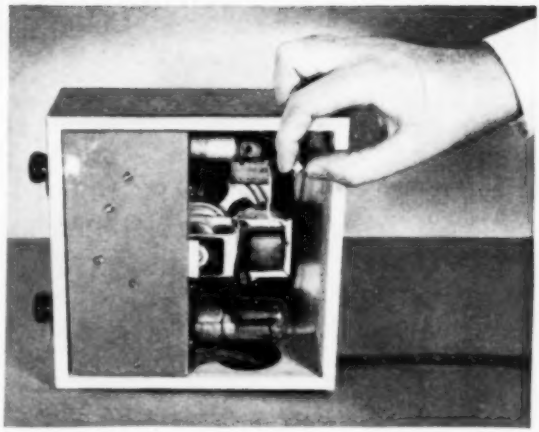

The pictorial diagram above makes it easy to follow the wiring connections

View below shows the cabinet and speaker, with chassis ready to be installed. Right, angle view of the finished set and brackets

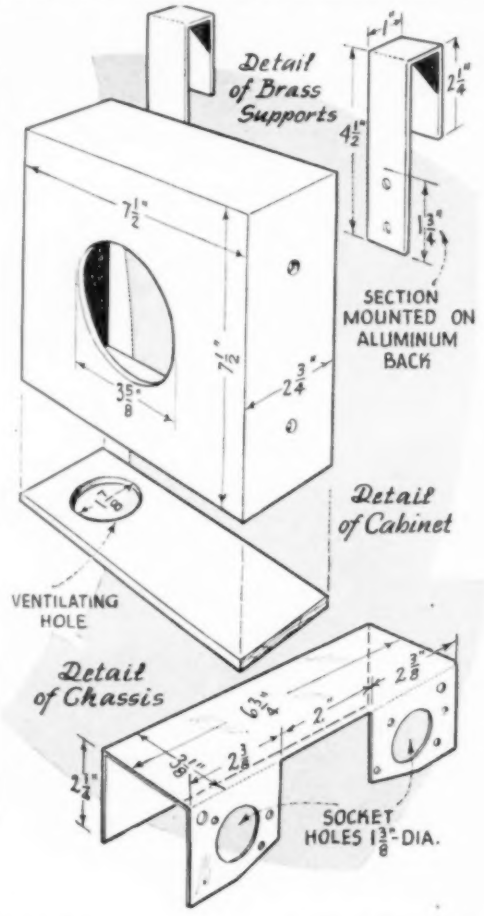


the sides ⅜" thick and the front about 5/16". A round hole of 3⅝" diameter is cut in front for the speaker and decorated with a round escutcheon from a tuning dial. The escutcheon may be purchased separately at any large radio store. Aluminum 1/16" thick is used for the back. To it, two brass strips ¾" wide, previously bent in a vise, are attached—each with two 6/32 machine screws and hex nuts. The angles shown in the drawing will do for most low-backed beds.

The large ventilator hole on the bottom side of the cabinet prevents the heat generated by the tubes from remaining inside the cabinet and melting the wax insulation on the tubular condensers, or causing damage to the finish on the bed (if wood) by heating up the aluminum back.



Rear panel before mounting. Chassis and cabinet details below




## LIST OF PARTS

Two-gang tuning condenser, .00036 mfd.
Antenna coil, unshielded.
RF coil, shielded.
Filter choke, 10 henry.
Line cord, 220 ohm (see text).
12B8GT tube (see text).
25A7GT tube (see text).
Permanent-magnet speaker, 4".
Output transformer.
Potentiometer, carbon, 50,000 ohm.
S. P. S. T. switch.
Octal wafer sockets (two).
Carbon resistor, 150 ohm, 1 watt.
Carbon resistor, 300 ohm, ½ watt.
Carbon resistor, 5,000 ohm, ½ watt.
Carbon resistor, 150,000 ohm, ½ watt.
Carbon resistor, 800,000 ohm, ½ watt.
Carbon resistor, 3 meg., ½ watt.
Electrolytic condenser, tubular, 10 mfd., 25 volt.
Electrolytic condenser, tubular, 16 mfd., 150 volt.
Electrolytic condenser, tubular, 20 mfd., 150 volt.
Tubular condenser, .1 mfd., 400 volt.
Tubular condenser, .05 mfd., 400 volt.
Tubular condenser, .02 mfd., 400 volt.
Tubular condenser, .01 mfd., 400 volt.
Mica condenser, .00015 mfd.
Mica condenser, .0002 mfd.

# One-Tube Receiver

## USES RECTIFIER AS DETECTOR

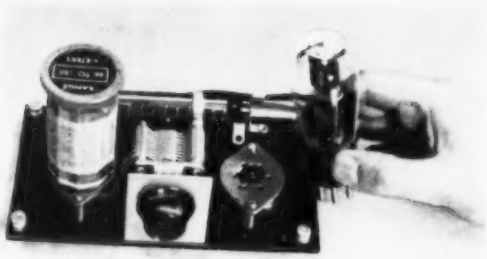
BASED on a novel and simple one-tube circuit, operating on the house current, this new type of radio receiver brings in stations as clearly as a crystal set, with absolutely no hum, and with fine selectivity and sensitivity.

Using a rectifier as a detector tube, no filtering system is needed because no plate voltage is used! The A.C. voltage is needed only to heat the filaments of the 25Z5, with no connections between the A.C. line and the receiver proper. The 25Z5 acts as a diode and has its two plates and cathodes tied together. The plates are connected to the fixed plates of the .00015-mfd. tuning condenser, to the four-prong coil, and to the antenna. The cathodes are connected to the moving plates of the condenser and to the other end of the grid winding on the coil. The phones are placed in the cathode circuit of the tube.

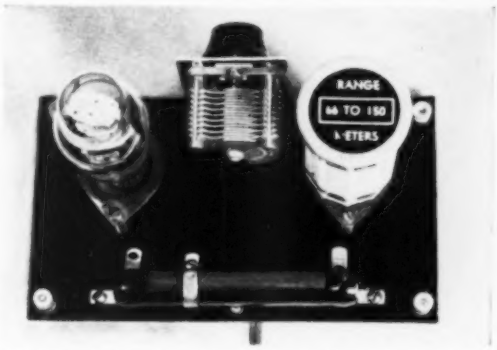
The rectifier heater voltage must be adjusted critically to from five to six volts, instead of the rated 25, for satisfactory operation. As there is no line cord on the market rated at 600 ohms, use an 80-watt fixed resistor with an adjustable tap. Otherwise connect two 300-ohm line cords in series.

### LIST OF PARTS

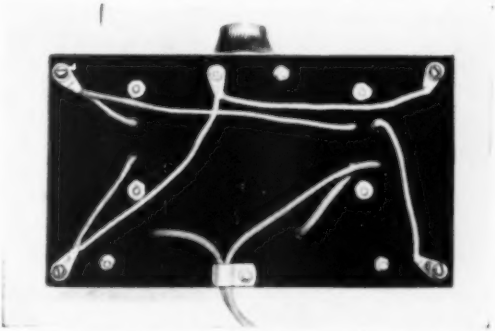
Tuning condenser, .00015 mfd.
Set of two 4-prong broadcast coils.
Rectifier tube, 25Z5.
Six-prong wafer socket.
Four-prong wafer socket.
Wire-wound resistor (tapped), 80 watt, 750 ohm.
Headphones, 2,000 ohm.
Line cord.
Black Bakelite panel for baseboard, 4" by 7".
*Miscellaneous:* Wire, solder, 20' indoor antenna, etc.



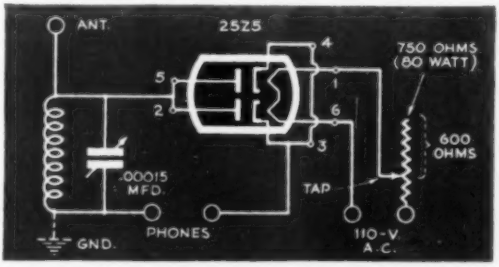
The complete receiver with its tube removed from its socket



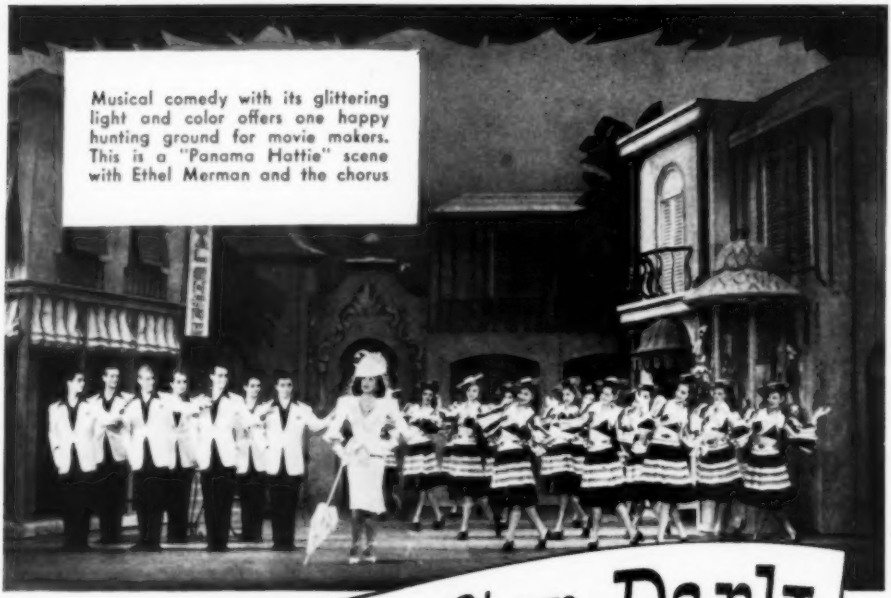

This close-up view shows how the four main parts are placed



Bottom view, revealing the extremely simple wiring of the set



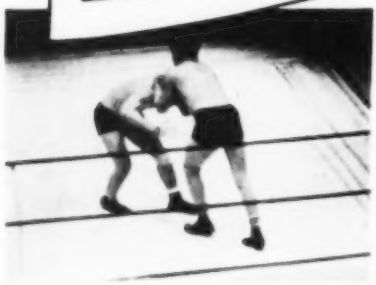

Only the heater uses power, so a ground may be safely used



Musical comedy with its glittering light and color offers one happy hunting ground for movie makers. This is a "Panama Hattie" scene with Ethel Merman and the chorus

# Movies After Dark

By ROBERT WOODMAN



Action aplenty is found at wrestling matches

WHEN the shades of night descend and the photographic value of the daylight wanes, most amateur movie makers conclude that their outdoor activities must necessarily cease. They hold to this despite the fact that they, themselves, have seen many interesting outdoor night movies. There seems to be an impression that some sort of special training or camera manipulation is necessary to make a success of such movies. Let us dispel this impression. With modern, fast films, outdoor night movies are easy to make. In the glitter and glow over highways, in shops, theaters, and arenas—wherever human beings gather for recreation—there is generally plenty of light for good pictures.

A few examples of what can be done are shown in the accompanying illustrations, all of which, except the large picture above, are enlargements of frames from amateur 16-mm. movies. Such enlargements do not, of course, begin to reveal the quality of the actual movie, but they are sufficiently clear to give some idea of suitable subject matter.

You don't need an expensive outfit. Even lower-priced cameras these days can boast of their f/3.5 lenses, and this stop will bring pretty fair

results under the bright lights with fast films rated at Weston values of from 64 up. Of course, there is no denying that a lens with a speed of f/1.9 or f/1.5 confers great advantages in making special types of after-dark shots; and, if you are out to shoot color, a fast lens is practically a necessity.

What can you take? No end of things claim attention because of their after-dark interest value. It isn't necessary that you inhabit a metropolis in order to have your own good chance for outdoor night movies. Any town has its Main Street, where enterprising merchants see to it that darkness doesn't conceal them or their wares. The coming of dusk to Main Street often makes a very pleasant picture.

Indeed, the effort to capture such a shot will form an excellent introduction to the whole subject of after-dark filming. There comes an hour in the early evening when objects are still visible by daylight, but when street signs, offices, and shop windows begin to be illuminated. This is an excellent hour to secure novel effects with fast film and a lens of medium speed because, in the resulting picture, the outlines of objects in the scene will show dimly, while the lights themselves will be brilliantly picked out. The shadowy details of objects will give all the lights their proper locations in the scene, and the general result is usually a very good one. Moving traffic will be outlined, with car headlights threading the maze of shadows.

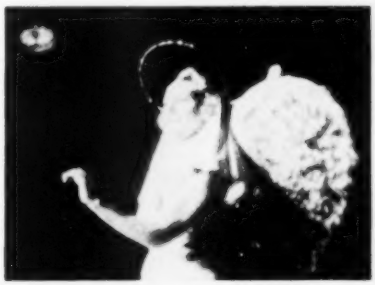
One of the most effective shots of this kind, taken by an amateur with an f/3.5 lens, showed a long line of cars coming across a hill road at twilight. There was just enough daylight to register the outline of the distant horizon against the sky. All the cars had their headlights on, and this gave the effect of a moving necklace of light.

A shot of an approaching, headlighted train, taken at dusk, is also very striking. Vehicular traffic crossing a bridge with its delicate tracery of cables still outlined against the twilight sky, offers an excellent application of this type of shooting.

As regards city traffic, an amusing effect may be secured, around this hour, by setting the camera at half speed. This will double the wide-open speed of the lens, so that a better exposure results. Of course, everything will move twice as fast in the resulting picture. It is unlikely that the lights themselves will be badly overexposed when half speed is used at this time.

As to exposure for twilight shots, the best bet for those who have lenses of moderate speed is to load the camera with fast black-and-white film, open the lens up wide and blaze away. Conditions vary so much with circumstance that it is impossible to give fixed exposure values. In the twilight an exposure meter, if used, will attempt to inform you that the light is unsuitable for filming. So it may be, if you want a full exposure. But here you are seeking an effect.

Animated signs fairly sparkle on the screen



From a movie entitled "Broadway Nights"

Even the opera has its moments for movies

The ballet, or any dancing, is a good subject

Comes night and complete darkness. Now for the real night shooting. The first subjects that attract many movie makers are the street signs. In the big cities there are more lavish displays of massed electric bulbs, but street signs of any proportions may be made effective by varying the camera angle and also by weaving such shots into a simple after-dark sequence.

An interesting and unusual photo-montage effect in motion can be made if you have the facilities for *rewinding the film in your camera*. Some cameras are provided with back-cranking devices which enable this to be done easily. Even if your camera does not have this, you can still achieve the effect if you want to go to the trouble of rewinding the film in a darkroom. Then you can load it into the camera again, cover up the lens, and run it off until the footage meter shows you have reached the original portion of your film on which you want to double expose another image. You can shoot some more moving signs on the same length of film, but at a different angle or in a different portion of the frame. As the background is always dark, the two shots will both register. This idea may be carried out in double, triple, or quadruple exposures, depending on your own plans and patience.

One amateur made special titles for his film of night life and produced a fine effect by double exposing shots of various animated electric signs in one corner of the title field. This he did by making an entire fifty-foot roll of titles alone, photographing white letters on a black background. Having kept a record of his precise footage for each title, he rewound the film and went out and shot the individual signs, sighting each through the finder so that only the upper left-hand corner of the frame contained a bright image. The lettering had been placed so as to leave this space vacant. The result was as professional looking a collection of titles as anyone could desire.

Now, as to exposure on bright electric signs placed far above the street, it is not always wise to attempt to determine this by the use of a meter. Not that our trusty mentor falls down on the job, but we are not interested in trying to compensate for the dark area against which the sign stands out. The meter will dutifully average the entire included area in its reading, which will not be the true exposure value for the light of the bulbs themselves. Consequently, the lens settings will have to be regulated largely by your own judgment.

If you are using panchromatic speed film in the camera, you will find it especially sensitive to the light of the incandescent lamp. With this kind of film, a stop of f/3.5 will usually record the sign very well. If there is a large, closely massed area of lights, try f/4.5 or f/5.6 with speed film. With ordinary pan film, on the other hand, better use nothing slower than f/3.5 or f/2.7. If color appeals, and you wish to record a sequence of colored signs in Kodachrome, it is better to have a fast lens and to open it wide. Use type A, of course.

With supersensitive black-and-white and a fast lens, shots can also easily be made by reflected light. Theater marquees, extending over the sidewalk, often form brilliant pools of light along the street. Take your stand at one of these, open up the lens, and capture the interesting parade of hurrying people—or perhaps the more leisurely ones in ermine and coiffure, top hats and white shirt fronts. If you and your camera are also to see the show, you will want to shoot the name of the attraction, outlined in lights above. A billboard close-up, if well illuminated, will also help. Remember, when using a fast lens wide open, that you must be careful in focusing, especially in close-ups. This is even more important in 16-mm. than in 8-mm.

Once inside, you find yourself in a good seat, centrally located and not too far from the stage. It is a musical comedy, with plenty of glitter and go; in fact, not too quiet, for in a quiet interval, the familiar buzz of a movie camera in the theater can be dis-

Sonja Henie in the glare of crisscross spotlights, and a scene from a six-day bike race film

concertingly loud. All right, yours doesn't buzz; it purrs. But try to make it purr unobserved.

Use discretion and a fast lens when you shoot inside the theater. Since the rash of candid cameras has broken out, some theaters have blanket restrictions on all cameras. But, if you are reasonable and don't buzz your camera in the midst of a dramatic hush, you'll probably get by. Pick your show. Have a word with the house manager in advance, if you can. There's always such a thing as coöperation.

For close-up shots of individual performers, or of small stage groups, a forward seat in the orchestra is best. For a more sweeping view of the entire stage picture, the loge, or first balcony front, is a good spot. Color is an excellent possibility, especially in the glittering revues where it runs riot amid a shower of spotlights. For color, open up the lens as wide as it will go—and that ought to be f/1.5 or f/1.9. If there is a special scene you want that isn't so bright, film it at half speed. The characters may speed up their actions, but at least you will have a picture.

Some thoroughgoing amateurs make their theater films more interesting by attending two performances of the same show, once seated near the stage and once in the front balcony. By intercutting the two sets of shots, variety can be obtained. Telephoto lenses also can be used, but a fast telephoto is rather bulky on a 16-mm. camera for theater shooting. With 8-mm., this is a slightly different story, but, of course, it all depends on the lens battery at your disposal.

You can even shoot another movie on the screen if your seat is at the right distance, although this is more of a stunt than a serious record. Use half speed with black-and-white film to get exposure and to avoid flicker.

Night clubs usually offer excellent material for the after-dark filmer—and here we may be tempted to add, "And how!" For there seems to be less formal restraint placed upon the occupants of a ringside table, and any little camera noise, added to the general confusion, doesn't matter.

Entertainments in large arenas are now regarded by all amateur photographers as legitimate hunting grounds, and the time has come when there are almost more flash bulbs than empty pop bottles under the seats when the crowd leaves the circus. The big opening parade, the clowns performing between the acts, the mammoth aggregations of this and that, the white-clad bodies of the trapeze artists flying through the air —all may be recorded with the greatest of ease.

Skating carnivals, with their bewildering volleys of crisscrossing spotlights, will give your camera an active workout. Boxing and wrestling are in a class by themselves for movies because of the flood of light with which the arena is drenched. Color isn't very necessary, but a ringside seat, even at some of the bouts of lesser importance, can yield black-and-white movies that literally pack a punch. This is one of the few after-dark occasions during which you may be able to make slow-motion movies.

One amateur made a film composed entirely of well-selected close-ups and long shots of wrestling bouts. The mighty heaves and earthquake tremors staged by the hairy behemoths for the amusement of the crowd, as well as the more scientific exhibition of the sport put on in the main bouts, provide excellent cinematic effects. In brightly lighted rings you can easily make telephoto shots and thus catch close-ups of the contestants' expressions. With "super" film, black-and-white shots of brightly illuminated boxing or wrestling arenas may be made at normal camera speed, with stops of f/4.5 or f/5.6.

The list of possible subjects is far too long to cover completely, but the main thing is—don't be too wary of night subjects. Good, fast film and speedy lenses are available. Let them bring you the fascinating pastime of night movie shooting.

The circus is a gold mine for movie makers. At right, Clyde Beatty in his lion-taming act

## Neat Plastic Drawer Knobs Improve Photo Gadgets

FOR use on photographic enlargers, tripod attachments, and other photo equipment, plastic knobs are superior to metal ones in several ways. They do not corrode, are pleasant to touch, and attractive to the eye. Such knobs are sold in dime stores as drawer pulls. Remove the screw, drill the hole to the required size, and thread it to fit the special part. Apply pyroxylin cement or plastic adhesive to the threads, and screw the knob into position. If the plastic is the type that softens in hot water, file the end of the shaft square, drill the hole somewhat smaller than the diagonal of the square end, and force the shaft into the hole after the knob has been immersed for a short time in water heated a little below the boiling point.—W. B.

## Thermometer Held in Place with Small Suction Cup

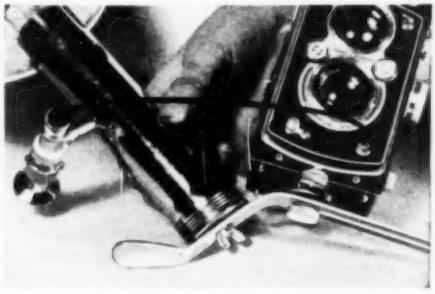
THERMOMETERS for photographic use are customarily made for hanging inside a tank and have no provision for holding them in one position. To keep a thermometer in place in a tray when it is rocked, buy a five-cent rubber suction cup, remove the hook from the thermometer, and bolt the cup in its place. This will hold the themometer at the bottom of the tray so it will not interfere with developing procedure in any way.—G. S. G.

## Weight Hung Beneath Tripod Will Keep It Steady

MANY blurred amateur snapshots are not due to a poor lens, bad focusing, or movement of the subject, but to movements of the camera. Even the use of a tripod will not prevent this movement unless the tripod is heavy enough, and on a firm enough support, to absorb the shock of the shutter mechanism when it is tripped. A good remedy is to suspend a substantial weight, such as a 6- or 8-lb. flatiron, from the underpart of the tripod. A light tripod then becomes as rigid as a much heavier and more expensive one. A strap is better than a cord for suspending the weight because it has no tendency to twist. Light tripods are especially wabbly when set on thick carpets.—K. S.

## Storing Chemicals in the Darkroom

NO MATTER how small your darkroom is, store all chemicals away from your stock of paper and films, and keep them in well-stoppered bottles or tightly closed containers.

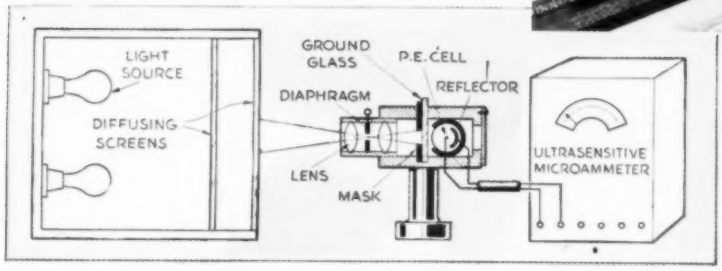


## Synchronizer Bracket Bent to Clear Camera Controls

SOME cameras have controls on the side so that operation is difficult with a synchronizer battery case and reflector strapped in place. In such cases bend the synchronizer bracket at an angle so the battery case will be supported away from the camera.

# LENS SPEEDS CALIBRATED IN NEW WAY

Dan B. Clark calibrating a lens. The light it transmits is measured by a photo-electric cell and meter




The lens holder, above, contains a ground-glass screen and the photo-electric cell. The whole set-up is shown diagrammatically at the left

PHOTOGRAPHERS have often wondered why one lens of a certain rating, such as f/4.5, will appear to be faster or slower than another similarly rated. This is because the ordinary method of rating lenses with respect to light speed by the ratio of the aperture opening to the focal length does not take into consideration the number of elements in the lenses, the arrangement of the elements, the different composition of the glass, and the light lost by reflection and absorption.

In movie work the discrepancy is particularly troublesome, because negatives of differing densities are often produced when lenses were interchanged during the shooting of a picture. To overcome this, Dan B. Clark, executive director of photography in the Twentieth Century-Fox Studios at Hollywood, Calif., has developed a new method of rating the speed of movie-camera lenses. The actual amount of light transmitted by a lens at various stops is registered by an ultrasensitive microammeter as the lens faces an evenly lighted ground-glass screen.

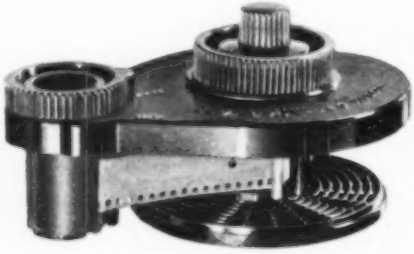
When being tested, the lens is mounted in a holder containing a ground-glass screen, which receives the focal image of the lens. Back of the screen is a photo-electric cell, the output of which is connected to the ultrasensitive meter. The system is standardized by measuring the light transmitted through a carefully selected reference lens set at the f/3.2 stop. The meter reading for this setting becomes the standard.

In calibrating a lens, the diaphragm control is operated until the meter reads the same level as on the standard lens. Thus, to insure transmission of the same amount of light on both lenses, corrections may be applied to each lens, permitting its substitution for another at any time. Results of the new method are more perfectly matched negative densities, especially on exteriors where light stops are constantly being changed.

# DEVICES FOR CAMERA USERS

**A NEW SYNCHRONIZER** suitable for shutter speeds up to 1/400 second is available for cameras that have front shutters of the setting type and standard cable-release sockets. The presynchronized magnetic tripper is adjusted to critical accuracy by means of a photronic testing machine, and no exposure tests have to be made by the user. There are two sockets, one placed vertically for 11A, 16A, and 21 photoflash lamps, the other centered in the back of the reflector for midget (No. 5) bulbs. Both are arranged for rapid ejection of lamps.

**EXPOSED 35-MM. FILM** can be transferred in full daylight from a miniature camera magazine to the new developing tank shown below. The film magazine is inserted in a small side chamber, and the leading end of the film attached to the tank-reel core. The lid assembly is inserted into the body of the tank and a knurled collar revolved to wind the film into the tank reel, when a knob is turned to cut the film. A final turn winds the free end into the reel, and the empty magazine can be withdrawn.



**DEVELOPING AND PRINTING** can be done at military posts, summer camps, on shipboard, or elsewhere away from home with the aid of the compact but complete developing outfit illustrated above. It packs into a small traveling case 7½" by 11" by 21", and weighs 14 lb. The outfit was designed especially for dyed-in-the-wool darkroom fans who have to serve a year in training camps, but it is equally useful under any conditions where a permanent darkroom is not available. Included in the equipment are an adjustable roll-film developing tank, three hard rubber trays, all-metal printing frame, ruby bulb, graduate, two ferrotype plates, print tongs, thermometer, chemicals, instruction booklet, and exposure record guide.

**DIRECT CHEMICAL RETOUCHING** of photographic prints is made possible by a new chemical kit. Undesirable backgrounds may be removed, lost detail brought back into the prints, and local sections retouched. Blemishes and lines can be erased from a portrait, and missing details in dark hair or shadows restored. Delicate gradations can be worked in.

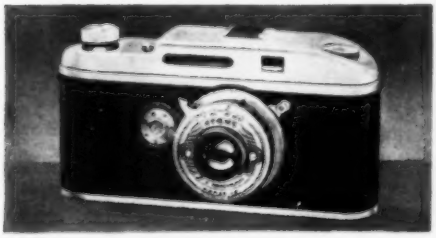
The method is said to work equally well on glossy or dull papers. Four chemicals are used —solution A, solution B, working control solution, and stop solution. The first two are the active solutions. The working control solution slows down their speed, and the stop solution arrests the action completely.

The developed print must be washed entirely free of hypo and should not be overfixed or have the emulsion hardened. However, after it has been retouched, it can be further fixed in an acid-hardener, hypo bath. The area to be retouched is first treated with the stop solution. Then equal parts of solutions A and B are applied with a fine sable brush, and, as soon as the desired effect has been obtained, the stop solution is dabbed on with a tuft of cotton. If the action proves too fast, a little of the working control solution should be added to the mixture of solutions A and B so as to reduce their speed.

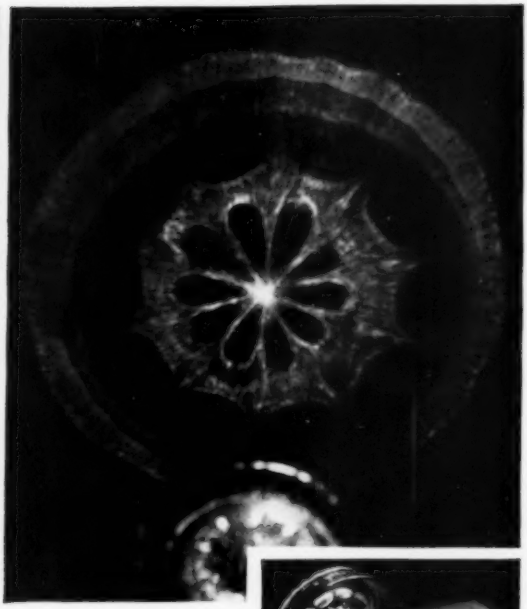
A mixture of chemicals is applied with a fine brush, and the action is halted at the proper point with a stop solution

**PATTERNED AFTER MACHINES** now used in nearly every motion-picture cutting room, this 16-mm. editor enables amateur movie makers to see the film in action while it is being edited. The film can be wound and rewound at will, or stopped for inspection of stills. The brilliant image is viewed through a high quality magnifier and appears four times the original size. No pressure pads can scratch the film.

**BUILT-IN EXPOSURE METERS** are a feature of these two new, reasonably priced 35-mm. cameras. The one illustrated at the right is designed especially for color work. Its f/4 anastigmatic lens is color-corrected far beyond the minimum required for faithful color reproduction. The meter is of the photo-electric type. In the second camera, which is shown below, an extinction-type exposure meter is used. This camera also has an f/4 lens. Both cameras have an automatic shutter mechanism accurately calibrated from 1/25 to 1/150 second.



This grotesque and ghostlike picture is obtained by photographing an image projected on the wall by shooting the beam from a pocket flash light through the set-up shown at the left



Light passed through a glass lemon juicer as at the right gives a design resembling a giant slice of fruit. The room must, of course, be darkened so the images show up clearly against the wall

## Queer Pictures Projected on Wall Through Glass

WEIRD, mystifying photos can be taken, to the wonderment of your friends, by the simple trick of projecting a beam from a pocket flash light through bottles, glass dishes, and other transparent objects. If the room is darkened sufficiently, countless curious images can be thrown on the wall in this way, and a few of the best selected to be photographed.

The example at the left above—a ghostlike face or mask—was obtained by setting one small glass dish on top of another and balancing a pair of spectacles across the top. The fruit-slice pattern alongside it was made by projecting the light through the bottom of an ordinary glass lemon juicer. An unearthly figure apparently surrounded by electric radiations was created, as at the right, by directing a flash-light beam through a small, empty bottle.

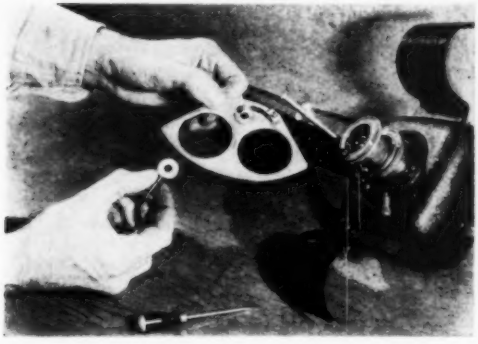
No one not in the secret would be apt to guess what this is. The light is merely projected through the bottle seen in foreground at bottom

## Quick-Change Holder Speeds Use of Filters with Enlarger

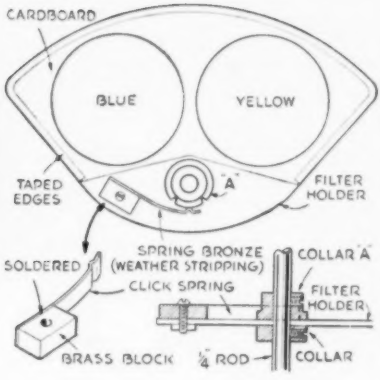
THOSE photographers who are using the new variable contrast papers for enlarging (see P.S.M., Feb. '41, p. 198) can save time by making a swinging filter holder in which to mount the blue and yellow filters used for controlling the degree of contrast.

A ¼" brass rod extending down from the enlarger body supports a fan-shaped piece of aluminum with two 1¾" diameter holes in it. The filters, which come in sheet form with each package of enlarging paper, are sandwiched between the aluminum and a piece of cardboard cut to the same shape. The edges are bound with lantern-slide tape.

A simple spring-click device causes the filters to stop so that they are centered below the lens when in use. They can also be swung entirely out of the way at times when no filtering action is desired.—WALTER E. BURTON.



Dimensions depend upon the enlarger. The notches in collar "A" are spaced to center filters under the lens




## File for Miniature Negatives Made from Mailing Tubes

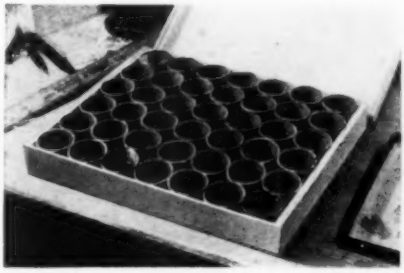
A HONEYCOMB filing case for 35-mm. negatives can be made by gluing short pieces of mailing tube in a cardboard box reënforced with wooden strips along the ends. Tubes from 1¼" to 1½" in diameter are the best size.

Before gluing in the segments, mark the bottom of the box in some sort of index system. A good way is to letter the top horizontal row A, B, C, and so on, and place numbers down one outside vertical row to give a coordinate index system (A-1, A-2, etc.)

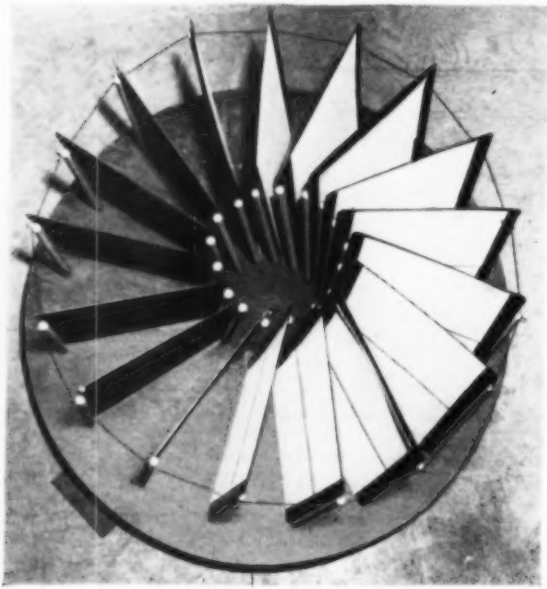
Each individual will prefer his own system of filing. An alphabetical or subject file may be used, or a combination of both, such as:

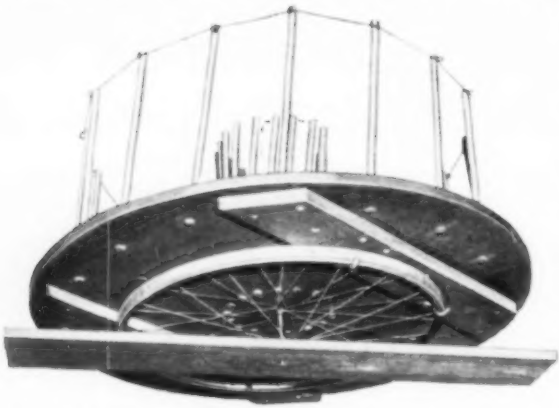
| LANDSCAPES | ROLL | NEGATIVES |
|---|---|---|
| Bear Mountain | A-4 | 7 to 9 |
| Cape Cod | D-6 | 10 |
| Dunny Creek | C-3 | 33 to 36 |

If necessary, each tube will accommodate seventy-two exposures instead of the customary thirty-six, thus doubling the capacity.—CARROLL E. BRADBERRY.

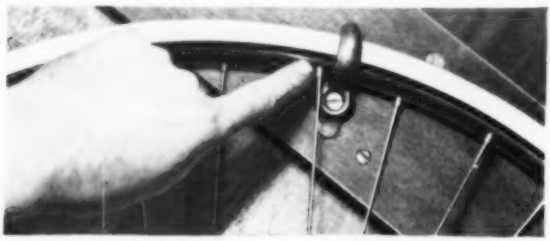


# Print Drier Revolves in Breeze Like Windmill





An electric fan is placed about two feet away to blow against the ferrotype tins. Below, how the bicycle wheel is fastened



ANY amateur photographer can build a print drier like the one illustrated. Its simplicity is rivaled only by its efficiency. This particular drier is used professionally and accommodates a large number of 8″ by 10″ prints, but by using a smaller bicycle wheel and reducing the other measurements to scale, the drier can be redesigned to take up less room.

It consists, in brief, of a circular platform mounted on an old bicycle wheel so it turns freely. Dowels project from the platform so that the ferrotype tins can be rested against them like vanes of a windmill. An electric fan is set up about two feet away to blow against the tins and turn the wheel.

For the size shown—that is, to hold seventeen 12″ by 17″ ferrotype plates—the materials necessary are: A 24″ diameter bicycle wheel and axle; four hooks such as are used by plumbers for supporting pipes; a 3″ by 5″ metal plate; 22′ of $\frac{1}{2}$″ wood dowels; 10′ of picture wire; an electric fan; some lumber, screws, staples, and miscellaneous supplies.

The metal plate (in this case brass) is screwed to a baseboard. The bottom of the hub rests on the plate, and the axle projects through below and also above through the center of the drier platform, which is 38″ in diameter. The rim of the bicycle wheel is attached to this platform, as shown, by means of the pipe-holding hooks.

The dowels, which are cut into 15″ lengths, are inserted in holes previously drilled in the platforms. Place the outer row about 3″ from the edge and 5″ apart. The inner row should be laid out in a circle approximately 5″ in diameter, and spaced $1\frac{1}{2}$″ apart. The picture wire is fastened around the outer row of dowels about 2″ from the top to prevent the ferrotype tins from slipping out as the breeze turns the wheel. Small staples driven into the dowels keep the wire in place.—BERNARD U. SOIBELMAN.

# 12,000,000 SUCCESSFUL SNAPSHOTS AT NIGHT

## Taken by average picture takers last winter

Just a little while ago, the average snapshooter was only half a snapshooter . . . all his pictures were outdoor pictures. But now, thousands are shooting indoors as well as out.

Using Kodak Super-XX Film—it's about four times as fast as ordinary film—they get as good snapshots indoors at night as they ever got outdoors in the sun. And you can, too—with any camera that takes Kodak Super-XX Film, even a $1 Baby Brownie. At dealers' . . . Eastman Kodak Co., Rochester, N. Y.

*Night Snapshots simple as A.B.C. with*

## KODAK SUPER-XX FILM

**A . . . Load your camera with Kodak Super-XX Film.**

**B . . . Use a couple of inexpensive Mazda Photoflood lamps in Kodak Handy Reflectors. (You keep your Reflectors, folded flat, in their attractive box. Kodak Handy Measure included.)**

**C . . . Follow brief, easy-to-understand instructions in the FREE booklet. Diagrams, exposure table, picture suggestions included.**

TOUGH

but oh so gentle

TOUGH ON OIL-PUMPING • GENTLE ON CYLINDER WALLS

If you're adding too many quarts of oil between changes, you're not only wasting money on oil but you probably are building up to an excessive repair bill. Oil-pumping usually means that rapid cylinder wear has started.

At the first sign of oil-pumping, it pays to replace your worn rings with Hastings Steel-Vent Piston Rings. They stop oil-pumping *and* check the rate of cylinder wear.

Any good mechanic can install them.

Note to Used Car Buyers: Ask the dealer if it's Steel-Vent Reconditioned. It's a better buy if it is.

HASTINGS MANUFACTURING COMPANY
HASTINGS, MICHIGAN • TORONTO AND WINNIPEG

HASTINGS
STEEL-VENT PISTON RINGS
Stops Oil-Pumping
IN CARS, TRUCKS AND TRACTORS


## Gus Almost Muffs One

*(Continued from page 146)*

force. You know how it is when you tie a weight on the end of a piece of string and whirl it around. After you get the weight whirling you can feel a pull on the string, and the faster you whirl it the stronger the pull is.

"Well, it's pretty much the same way with a badly out-of-balance tire. Without stopping to figure it out with pencil and paper, I'll bet that those two patches produce a centrifugal force of several pounds when the car is moving along fairly fast. When the patched side of the tire is on top the force is upward, and it makes the wheel bounce upward; when the patched side is at the bottom it makes the wheel bounce downward again.

"But that isn't all of it. When the patched side of the tire is at the front the force is forward, and makes the wheel and the spindle move forward—and as the spindle is pivoted at the king-pin it makes the wheel run inward; when the patched side is at the rear it makes the wheel and spindle move rearward and makes the wheel run outward. The result is that the spindle moves around in a small circle at the same speed and in the same direction as the wheel is turning. And the result of *that* is that the wheel bounces up and down and runs inward and outward every time it turns—and that's shimmy."

Bill thought it over for a full minute, and then nodded. "I get you," he said. "Well, next thing is what are we going to do about it?"

Gus took another look at the out-of-balance tire, and then examined the three others. "Well," he said, "we *could* fix it up by putting wheel-balance weights on the light side of the patched tire, opposite the patches. But it's past time for Silas to take the elastic band off his roll and invest in some new rubber. He hasn't got a tire on this bus that *I'd* ride on! I'll call him up and break the bad news to him. He's a tight, crusty old cuss, but I sort of like him somehow, and I wouldn't want him to break his skinny old neck!"

### Question Bee Answers

CHECK your answers to the Question Bee on page 132 with the list below.

| | | | | |
|---|---|---|---|---|
| 1. b | 2. b | 3. c | 4. c | 5. b |
| 6. a | 7. c | 8. c | 9. b | 10. b |

# You may worry about that antique chair

## but here is one worry you can avoid

The jolt to your wife's prized antique chair when Uncle Henry sits down is nothing compared with the pounding road shocks constantly transmitted to the chassis parts of your car. You can't save your chair but you can save your car—

Save it from premature wear of "king pins" which causes "wheel shimmy"—save it from wear that causes rattles and other chassis troubles.

Just drive in where you see the red and white sign "Let Us Marfak Your Car" and get Texaco's famous 40-Point Chassis Lubrication Service from a trained expert.

Marfak lubricant is different. It is made of special highly refined heavy-bodied oils. Sticks to its job, outlasts ordinary grease. That's why it's the choice of leading bus lines—and your best way to avoid lubrication worries.

**TEXACO DEALERS INVITE YOU TO ENJOY**

**FRED ALLEN** in a full-hour program every Wednesday night. CBS, 9:00 E.S.T., 8:00 C.S.T., 10:00 M.S.T., 9:00 P.S.T.

**METROPOLITAN OPERA** every Saturday afternoon, NBC. See local newspaper for time and station.

**TEXACO'S 40-POINT CHASSIS LUBRICATION SERVICE AT ALL TEXACO AND OTHER GOOD DEALERS**

# Build this MASONITE* RECORD CABINET!

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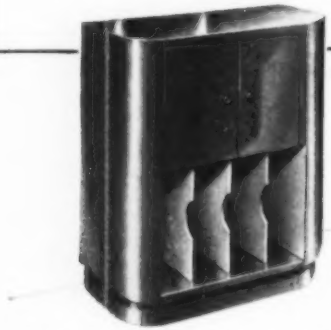

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*If you live in Canada, write Masonite Company of Canada, Ltd., Gatineau, Quebec.*


## What Has America Learned from the War?

*(Continued from page 59)*

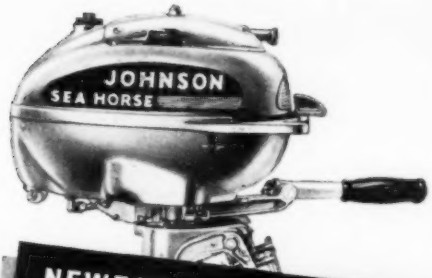
have been innumerable cases of planes returning in flyable condition full of .30-caliber holes. One explosive bullet or small shell is more effective than a barrage of nonexplosive projectiles.

Some British commentators think ill of four-engine bombers. They assert that the four-engine type was based on peacetime theories and tnat a year of war has drastically modified the requirements—which would of course apply to their Sunderlands as much as to our Boeing B-17s. This school of thought prefers smaller, faster bombers which can be used in daylight. However, the reports on the B-24 (Consolidated Model 32) are rather favorable. This carries four 1,200 h.p. Pratt and Whitney Wasps and has a top speed of 300 m.p.h. It has British turrets in nose and tail.

An item of interest to those who would like to see more experimentation with transports converted into bombers is the exceptionally favorable report on the Lockheed Hudson, which is a converted airliner. The undercarriage is said to be weak, but this model has fought off and shot down Heinkel HE-115 seaplanes and Messerschmitt 110's. It has been used more for reconnaissance than for bombing, but so far it seems to be one of the most useful types we have sent over.

The British predict that eventually all fighters will be equipped with turrets. They favor two-seater fighters, especially for night work; it is becoming increasingly difficult for one man to do both the fighting and the piloting. They expect that future day bombers will have fighter performance and little or no armament. "If there is fighting to be done, its escort will have to do it," one writer predicts. "The part of the bomber will be simply to bomb and run."

There are many serious problems of mass production of military implements which have not been solved. In design, also, mistakes have been made, and there is no guaranty that they will not be made in the future. All that can be said for the technicians is that they learn from their mistakes rather quickly and don't keep on making the same ones over and over, as is the rule in some other lines of human endeavor. No nation has a monopoly on technical skill; they are all exporters and importers. But we may be sure that our technicians, adding what they are getting from abroad to their own endowments, will give a good account of themselves.

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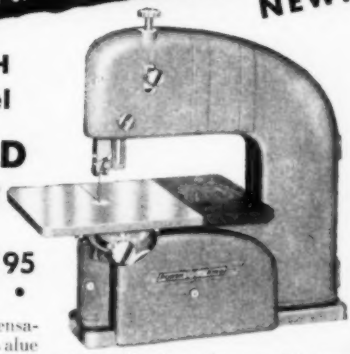

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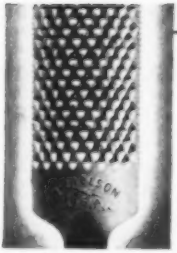
# Is your file knowledge keeping pace with progress ?



This fast-moving industrial world is constantly creating new problems requiring new tools and methods. From the needs of the airplane industry, for instance, was born this special half-round Aluminum Rasp, used for roughing down flat and curved surfaces (such as airplane propellers). For finishing, the Aluminum Type "A" File (*lower*) is used. Both have features for faster and more efficient working on aluminum and other ductile metals—in *any* industry. Made in both Nicholson and Black Diamond brands.

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## Blueprint Gives Details of Ideal Workbench

THE very foundation of the home shop is, or should be, a sturdy workbench—preferably with ample leg room to permit sitting while at work, and with plenty of drawer space in which to keep small tools and fittings. This bench, designed by Edwin M. Love especially for the POPULAR SCIENCE model workshop and illustrated above, is of husky bolted construction and can keep on "taking it" year after year, whether you build 20' cabin cruisers or 6" bird houses. It packs a lot of utility into a floor space 24" by 58", has an ingenious stop that replaces the usual end vise, and built-in rollers for easy shifting. Blueprint No. 405, price 25 cents, includes plans and list of materials.

For a complete list of our blueprints, send a self-addressed, stamped envelope. The following is only a partial list of the many interesting projects available.

**FURNITURE**

| | |
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| Bedside Cabinet, with automatic light in top drawer; also Fireplace Screen and Trinket Box, 389A | $ .25 |
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| Floor Lamp, with tripod base, 243A | .25 |
| Four-Leaf Card or Occasional Table, 239A | .25 |
| Hanging Wall Cabinet, 9½" by 24" by 41¾", 280A | .25 |
| Magazine Rack, ladder-back style, 250A | .25 |
| Silverware Chest on Stand, 256A | .25 |
| Smoking Stand, modern, 238A | .25 |
| Upholstered Stool, 210A | .25 |

**BOATS**

| | |
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| Cabin Cruiser, 17' long, for use with outboard or inboard drives, 356-357-358-359-R | 1.50 |
| Camper's Utility Boat, 11' 2" long, canvas-covered, for outboard motor or rowing, 281-R | .50 |
| Canoe, 16' canvas-covered kayak; can be used with sail, 192-193-194-R | 1.00 |
| Canvas-Covered Duck Boat, 13' 6" long, 279-R | .50 |
| Family Runabout, 13' 5½" long, weighs 275 lb., for outboards from 1 to 60 h.p.; can also be rowed, 378-379-380-R | 1.50 |
| Fisherman's Outboard Boat, 9' 3" or 11' 6" long, weighs 115 or 160 lb., for motors from 3 to 16 h.p.; can also be rowed, 344-345-R | .75 |

*(Continued on page 223)*

# Blueprints for the Shop

*(Continued from page 222)*

Inboard Boat, 15' long, for motors from ½ to 5 h.p.; can also be rowed, 384-385-R..... .75
Lapstreak Skiff, 13' 9" long, weighs 225 lb., for 1- to 16-h.p. outboard motors, 363-R..... .50
Midget Boat or Pram, 9' long, weighs 75 lb., for oars, sail, or outboard motor, 339-R..... .50
Motorboat-Rowboat, 13' long, decked hull, for use with outboard or inboard drives, 147-R..... .50
Same, 14½' long, 148-R..... .50
Same, 16' long, 149-R..... .50
Plywood Dinghy, 9' 7" long, weighs 60 to 75 lb.; can be rowed, sailed, or used with small outboard motor, 387-388-R..... .75
Racing Runabout, 13' stepless hydroplane for outboard motor, 261-262-R..... .75
Racing Sailboat BLACKCAT, 13' 4" long, weighs 250 lb., Marconi rigged, 321-322-323-R..... 1.00
Sailboat, 12' long, weighs 200 lb.; has fast skimming-dish hull, 314-R..... .50
Sectional Rowboat, 9' 8" long, two sections, weighs 60 lb., all-wood construction; can be used with small outboard motor, 310-341R.... .75

### MODELS

Barnegat Lighthouse, 10½" high, 298A..... .25
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Clipper Ship GREAT REPUBLIC, 31½" hull, 272-273-274-R..... 1.25
Clipper Ship SEA WITCH, 9½" hull, 219..... .25
Concord Stagecoach DIAMOND TALLY-HO, 20½" long, 115-116-117-R..... 1.00
Confederate Raider ALABAMA, 21½" hull, 335-336-337-R..... 1.50
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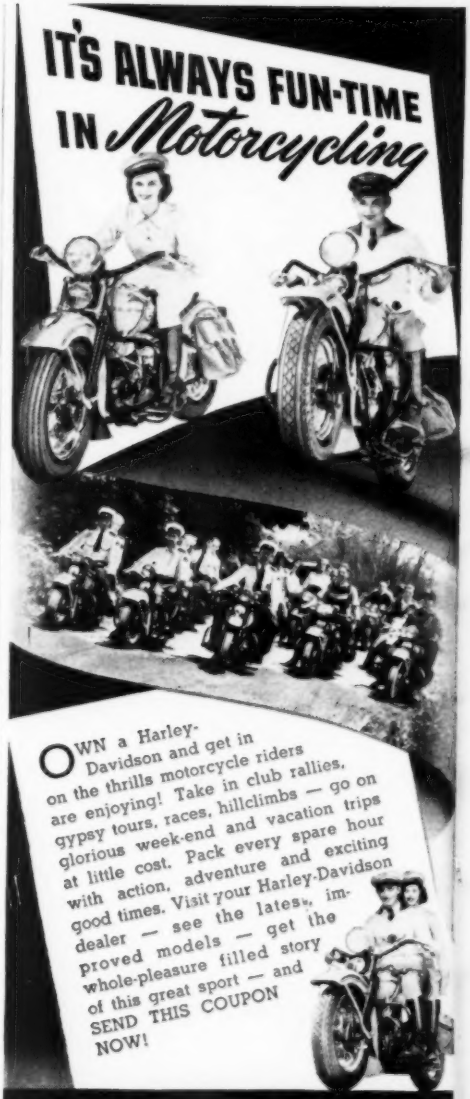


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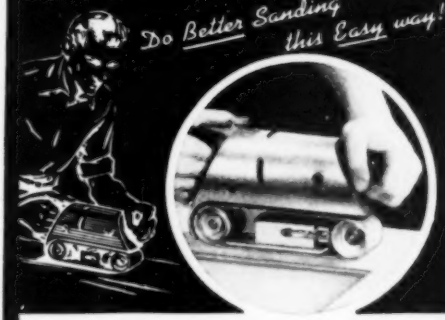

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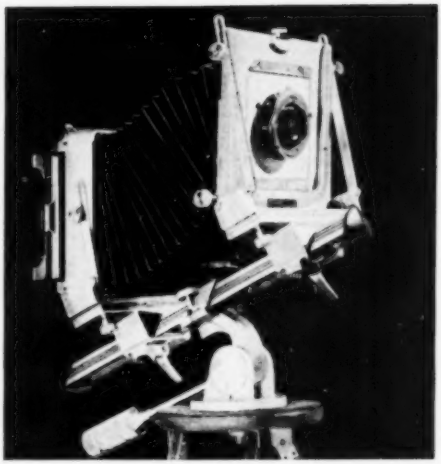

## New All-Metal View Camera Is Completely Adjustable

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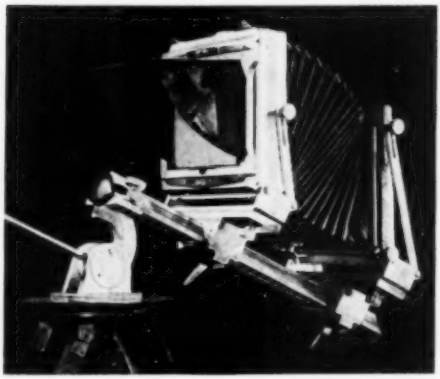
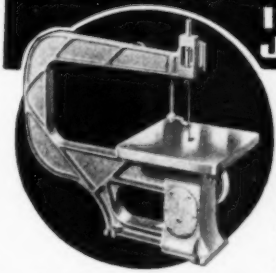


# SUPER-VALUE 12 INCH JIG SAW



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## *Denver Students Learn Movie Making*

*(Continued from page 80)*

an astonishing grasp of our operations." "So am I," a dairy operator agreed. "I never knew 'teen-agers could be so serious." Dr. Mitchell of the State health laboratory is enthusiastic. "We haven't the time or the personnel to guide visitors through the laboratory," he said, "yet everyone ought to know about our work. This is an ethical way to advertise health. I hope every state does the same thing."

Every educator concerned, from the teachers in Denver to Dr. George F. Zook, president of the American Council on Education, finds it the answer to prayers for a comprehensive means of holding pupil interest, of instilling facts, and of educating the whole personality.

If numerous school systems institute pupil-made motion pictures, a fruitful exchange can result. Eugene H. Herrington, production manager of the Denver project, says you don't need expensive equipment. An adequate camera will cost $50, an ordinary projector $75, a sound projector $300. Sometimes the camera can be borrowed from a local amateur, and with the spread of visional education many schools already have projectors. A finished sound reel may cost $150, of which $36 went for film, $20 for printing, and $17.50 for sound track. There is no personnel cost, for the school uses its teaching staff plus an outsider qualified—and glad—to act as technical director. Serious study on the part of the students, and careful direction by vital and imaginative teachers, are the essential ingredients. A manual for teachers has been prepared by the Motion Picture Project of the American Council on Education, Washington, D. C.

Each section of the country offers something special for its children to document—shipping, fruit growing, or textile manufacture, or local differences in the way people live and work. Even the best adult-made educational films aren't so satisfactory as those of, by, and for the high school.

Education via the self-made cinema is in the Denver curriculum to stay. Pupils learn better and what they learn stays with them longer. But the scheme cannot be measured merely in terms of knowledge gained. Young motion-picture producers who have learned to meet people, to make difficult decisions, to be thorough and think straight, and to work together, are, in the fullest sense, educated.

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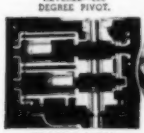

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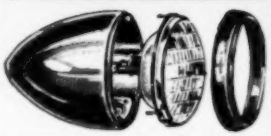

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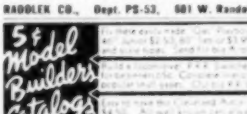

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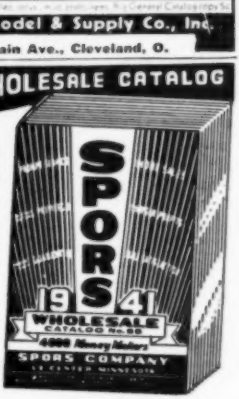


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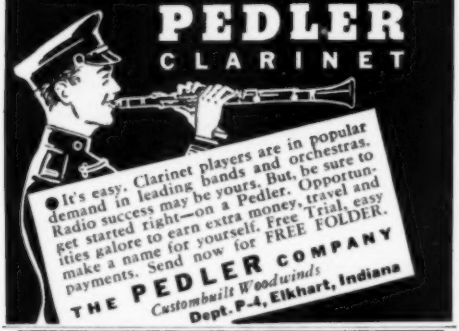

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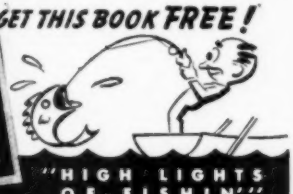

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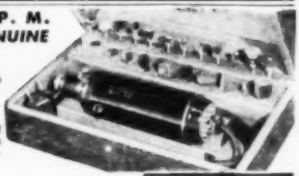

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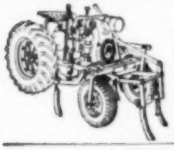

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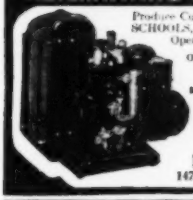

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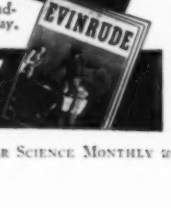


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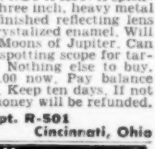

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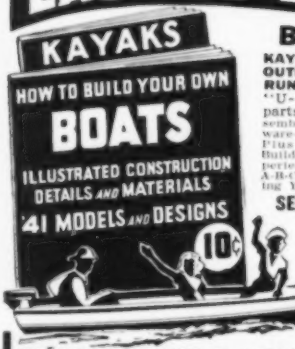


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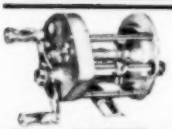

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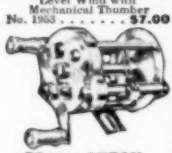

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New shadowless, glareless light everyone is talking about, recognized as the greatest improvement in lighting since Edison discovered the electric lamp, can now be yours at a fraction of the regular cost. Your fluorescent light will give you twice the light of your incandescent built with less eye strain while using only one half the electricity. This will enable you to cut your light bill in two.

## FLUORESCENT FIXTURES

For HOME, WORKSHOP, STORES, OFFICES AND FACTORIES

Fluorescent lighting offers the greatest opportunity in America today for young men to establish themselves in their own business as trained sales and service men. Fixtures pictured on this page are now retailing for $5.50 to $10.00. Write now for complete details to learn how you can establish yourself in a very profitable business assembling and selling our complete line of Fluorescent fixtures. **Be the first in your town.**

**NATIONAL FLUORESCENT SALES AND SERVICE COMPANY**
Dept. L 404 North Wells Street Chicago, Illinois

Modern wall and ceiling fixture.

Complete kit **$2.75** plus postage

BULB 75 cents extra

Polished metal and caps. White enamel body. Price includes switch

## $150 to $300 PROFIT MONTHLY WITH ARC WELDING

"BUILD-YOUR OWN" Simplified ARC WELDER

Couple this complete Hobart generator to a used auto engine and mount on chassis and get the money-making equivalent of a complete factory-built gas drive welder costing from $300 to $500 more.

Arc welding is today's biggest money-making opportunity! Start in business for yourself and easily earn from $150 to $300 profit every month. With Hobart, welding is easy, faster and will bring you the big pay jobs that carry a real profit.

ONLY $20 MONTHLY quickly pays for your Hobart welder. The profit on a single job will usually take care of this small payment . . . letting you own your welder with practically no expense to you!

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FREE! 4 VALUABLE BOOKLETS on WELDING
CHECK YOURS, WRITE NAME AND ADDRESS IN MARGIN AND MAIL

- ☐ How to "Build-Your-Own"
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Liberal Trial at our risk on "pays for itself" terms

HOBART

Fastest Selling Arc Welder on the Market Today

"that's SIMPLIFIED"

## HERE'S WHAT USERS SAY ABOUT HOBART ARC WELDERS

"I've used all popular makes in several different models, yet I believe Hobart has the edge on them all."

"I am very well pleased with my Hobart Welder. It has turned out to be the best investment I ever made."

"I certainly am satisfied with my Hobart Welder. It costs me much less to operate than I thought."

"My Hobart certainly does the work with plenty of pep. In 4 jobs I made $46.00 for nine hours work."

**HOBART BROS. CO., Box P-41, TROY, OHIO**

## How to equip a better Home Shop

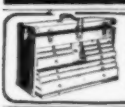
Vague printed claims alone don't make one brand of merchandise better than some other. That is specially true of power tools. Buy carefully! Make actual comparisons of capacity—materials used—precision or lack of it in machining and assembling of vital machine parts.

Industry buys equipment just that way. That's why industry indicates preference more often for Boice-Crane. Make sure your homeworkshop is most up-to-date, one that gives maximum enjoyment of precious spare time. Get the 1941 Boice-Crane FREE power tool catalog NOW, and hurry and see them at your local, friendly Boice-Crane dealers. *See what quality tools really are!*

**SEND FOR NEW 1941 CATALOG OF FULL LINE**

Include 10c for 16 pg. book that tells how to spin metal on your lathe.

**BOICE-CRANE COMPANY**
DEPT. 440 TOLEDO, OHIO



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Every Machinist and Toolmaker wants one someday. Choose yours NOW from Free Catalog.
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Your present power bill will buy a WITTE that produces power and light for 1c a K.W.H. Save up to 75%—a size for every need. 3 to 30 K.V.A.; 1, 2 and 4 cylinders. Write today for finance plan, literature and name of dealer.

**WITTE ENGINE WORKS** 2224 OAKLAND AVE. KANSAS CITY, MO.

**OTTAWA LOG SAW $39** BIG BOOK FREE

PUTS THIS **OTTAWA** to work for you. **MAKE MONEY!** Wood is valuable. Uses more than 10 men. Easily operated. Fells trees—saws limbs. Use 5-hp. engine for other work. **Write for FREE Book.**
SAW 10 TO 20 CORDS A DAY
OTTAWA MFG. CO.
2101 Wood St., Ottawa, Kans.

**SpeedWay DRILL $7.95 GRINDER $5.95**

**Quality Tools**—products of SpeedWay, for 30 years leading manufacturers of electric tools. Specially wound high torque 110V universal tool motors. Improved designs; correct speeds, 1000 RPM **Drill** with die cast handle has ¼" capacity in steel. 20,000 RPM **Hand Grinder** has speed essential for efficiency and collets for both ¼" and 3/32" arbors. **Drill** and **Grinder** sold singly or together with 5 accessories in fitted Steel **Kit. Stand** takes either drill or grinder. **Router** Frame converts grinder into router. **Bench Grinder** is complete with motor. Adjustable rests, rubber feet and cord. Write for Circulars.
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# SCIENCE CREATES THE PERFECT GLUE

# CASCAMITE

**Cascamite (the PLASTIC RESIN glue by CASCO) is revolutionizing industrial gluing. Now it's ready for YOU. Simplifies workshop gluing, guarantees greater success in all your projects.**

**FAST**—Mixes in a moment—in cold water. No heating. No waiting.

**WATERPROOF**—Actually stronger than the wood—even after prolonged soaking. Ideal for boats, outdoor construction.

**DURABLE**—Unaffected by mold or exposure.

**STAINFREE**—Won't discolor thin veneers, oak, mahogany, etc.

**ECONOMICAL**—Spreads *thin*. For veneering and indoor work, it can be extended with inexpensive household flour.

**RELIABLE** Cascamite is made by Casco, manufacturers of Casco Powdered Casein—Leaders in glue products for over 30 years and America's pioneer in the development of synthetic urea resin glue. Sold by leading Hardware, Paint and Lumber Dealers—10c, 25c, 50c, 85c.

**Send 10c for a generous TRIAL CAN of CASCAMITE and "Mighty Facts" folder—complete directions for foolproof gluing.**

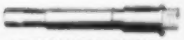
**CASEIN COMPANY OF AMERICA, Dept. PS-441**
**350 Madison Avenue, New York, N. Y.**
Here's my dime. Send trial can CASCAMITE and "Mighty Facts" folder.

*Name*_____

*Address*_____

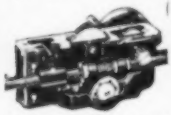
# *Precision is Assured* IN A SOUTH BEND LATHE

**HEADSTOCK.** Cutaway view showing integral type bearing and the capillary oiling system.

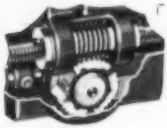


**SUPERFINISHED SPINDLE** is made of alloy steel with bearing surfaces carburized, hardened, ground and superfinished.

**IMPROVED SADDLE** and compound rest with adjustable tapered gibs. Cross slide bridge is wide and deep, providing rigid support for the tool rest.

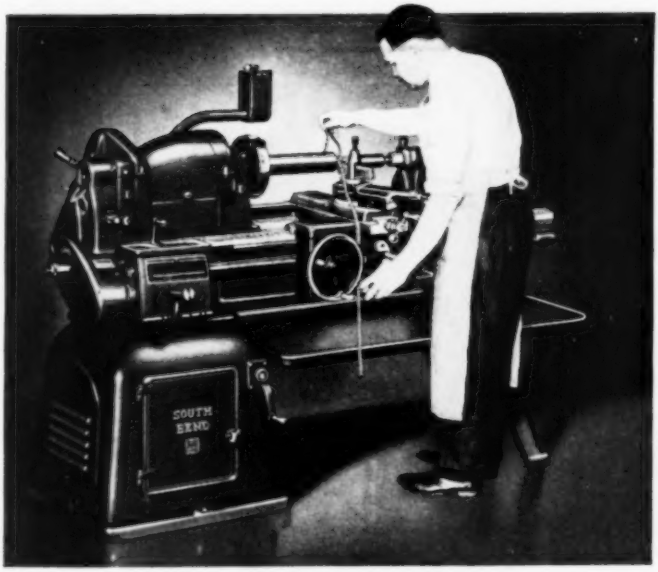


**DOUBLE WALL APRON** is rigid box type construction with all steel gears running in oil bath.



**MULTIPLE DISC CLUTCH.** Cutaway view shows alternate keyed steel disc construction.

**UNDERNEATH MOTOR DRIVE.** Belt drive to spindle is smooth and powerful and provides a wide range of spindle speeds.




**PRECISION IS ASSURED** in South Bend Lathes by combining fine workmanship with sound machine design. Expert mechanics fit each unit with an exactness known only to the machine tool builder.

South Bend Lathes are used in tool rooms of nationally known manufacturers for the most exacting classes of precision work. They are also used for production operations on interchangeable parts requiring a high degree of accuracy. Conveniently located controls assure an ease of operation which results in a uniformly efficient rate of production over a long period of time.

South Bend Lathes are manufactured in over 65 sizes and types. Popular sizes are available for delivery from dealer display stocks in important cities. Made in 9", 10", 13", 14½", and 16" swing, in 3' to 12' bed lengths, in Countershaft and Motor Drives.

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Cleveland, Ohio—Reynolds Machinery Co.
Dayton, Ohio—C. H. Geoniger Mach. Co.
Detroit, Mich.—Lee Machinery Company
Los Angeles, Cal.—Eccles & Davies Mach.
New York, N. Y.—A. C. Colby Mach. Co.
Philadelphia, Pa.—W. B. Rapp, Machinery
Pittsburgh, Pa.—Tranter Manufacturing Co.
Portland, Ore.—Portland Machinery Co.
Providence, R. I.—Geo. T. Reynolds & Son
Rochester, N. Y.—Ogden R. Adams
St. Paul, Minn.—Robinson, Cary & Sands
San Francisco, Cal.—Moore Machinery Co.
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*Boston Sales Office: 67 Bdway, Kendall Sq., Cambridge, Mass., Tel. Trowbridge 6369.
†Chicago Sales Office: Room 308, Machinery Sales Building, Telephone State 7285.

## SOUTH BEND LATHE WORKS

*LATHE BUILDERS SINCE 1906* — 821 E. Madison St., South Bend, Ind., U. S. A.

# 1000% to 1500% PROFIT— GET IN ON BIG CASH EARNINGS

is not unusual in the COMPOSITION NOVELTY MANUFACTURING BUSINESS and—it costs you very little to get started. Stewart's Studio has started thousands in this profitable business and daily we receive letters telling us of the big profits they are making.

## No Experience Required—It's Easy—Actually Fun!

Stewart's complete illustrated instructions fully explain every step in simplified detail—tells you how to make genuine flexible, long-life rubber molds—how to cast and finish beautiful, fast-selling novelties of plaster, liquid marble, plastic, cement, etc. Just select models you like and order these kits or if you wish order the complete rubber molds so you can start production immediately. Stewart's liquid rubber and rubber molds are regularly used by many of the largest manufacturers in this country. You can, therefore, place your order with the full confidence you are getting the finest materials that money can buy.

No. 1. 4½"x4"

No. 2. 4½"x3¼"

No. 3. 3"x3"

No. 4. 3"x3"

Kit consists of model 1, 2, 3 or 4. Stewart's Rub-er-Spra for making rubber mold and complete illustrated instructions. Specify model wanted. Kit only $1.25 ea. SET OF 4 KITS . . . only $3.75

**$1.25 ea.**

### SPECIAL OFFER

Completed genuine rubber mold—READY FOR USE—of any of the above models only $2.50. Set of 4 molds only $7.95.

### NEW IMPROVED Rub-Er-Spra

Better than ever—still by far the world's finest mold-making material. It's economical to use the best. Quart only $2.95. Gallon complete with spray gun and fully illustrated instructions only $6.95.

**$6.95**

No. 5. 5½"x6½"

No. 6. 5½"x7"

No. 7. 13½"x3½"

## BIG DEMAND For Novelties

Importation of novelties from other countries is at practically a standstill now. This condition has developed a tremendous shortage and many customers report they are weeks and even months behind on orders. It's a break for you—get started now and cash in on some of this profitable business.

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### COMPLETE KIT ONLY $3.95 ea.

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Completed genuine rubber mold—READY FOR USE—of any of the above models only $7.95. Set of 4 molds only $24.95.

### ORDER SEVERAL KITS OR MOLDS AND TAKE ADVANTAGE OF THE BIG CASH SAVINGS

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No. 10. 11"x8"

No. 11. 11"x7"

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IN A CIGARETTE

# THE SMOKE'S THE THING!

THE SMOKE OF SLOWER-BURNING CAMELS GIVES YOU

**EXTRA MILDNESS, EXTRA COOLNESS, EXTRA FLAVOR, AND—**

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than the average of the 4 other of the largest-selling cigarettes tested—less than any of them—according to independent scientific tests of the smoke itself

**"SMOKING OUT" THE FACTS** about nicotine. Experts, chemists analyze the smoke of 5 of the largest-selling brands... find that the smoke of slower-burning Camels contains less nicotine than any of the other brands tested.

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